The effects of online Team-Based Learning on undergraduate nursing students' performance, attitudes and accountability during COVID-19 pandemic

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Abstract. *Background and aim:* The COVID-19 pandemic forced many institutions to move Team-Based Learning (TBL) to an online format. The primary aim of this study is to examine the performance of undergraduate nursing students on team Readiness Assurance Test (tRAT) and individual Readiness Assurance Test (iRAT) during online TBL. The secondary aims are to evaluate the students' attitudes and their accountability, preferences and satisfaction with online TBL. *Methods:* The study employed a one-group pretest-posttest quasi-experimental design. The primary outcome was evaluated by comparing the students' average scores in the tRAT versus the iRAT in each online TBL session. The secondary outcomes were evaluated through a structured questionnaire and the Team-Based Learning Student Assessment Instrument (TBL-SAI). *Results:* A statistically significant improvement was identified between tRAT and iRAT performances in all online TBL sessions (p<0.001). Students' satisfaction with team experience showed a statistically significant increase (p=0.003). Participants considered the peer evaluation to be fair (p<0.001), although it didn't encourage them to study more (p=0.028). Finally, students felt they were able to make the right decisions (p<0.001). The mean scores for accountability (m=30±3.7) and preferences for TBL (m=51.8±6.3) were higher than their neutral values (n=24; n=48). Students' satisfaction was neutral (m=27.8±5, n=27). *Conclusions*: In online TBL, teamwork has improved individual performances and has been appreciated by the participants. The online TBL had a positive effect on the accountability of students who preferred it to frontal lectures. (www.actabiomedica.it)

Key words: Team-Based Learning, nursing students, distance education, COVID-19, accountability

Introduction

In these last years, a new generation of students born between 1995 and 2013, called "Generation Z", are entering higher education and the workplace (1). Nine main characteristics of Generation Z students can be identified in the literature (2) and knowing these generational traits can assist nurse educators in successfully recruiting, engaging and supporting future nurses (1-2). Members of this group are digitally native and accustomed to using handheld devices and surfing the Internet. Due to constant exposure to technology, they have underdeveloped social and relationship skills, an increased risk for isolation, anxiety and depression and a limited attention span, therefore, they tend to get easily bored by repetition. They are also pragmatic, individualistic, open-minded, cautious and prefer sedentary activism (2).

In education, generation Z students desire individualised, technologically advanced and visually

based learning (1). To meet those needs, nurse educators should consider replacing the traditional academic approach dominated by teacher-centred, passive teaching-learning strategies with active, student-centred approaches (2).

A recent integrative literature review on active learning in nursing education has identified several different strategies that might be adopted by institutions for the training of nurses (3). The analysis of these methodologies provided some evidence of their relevant contribution to nursing education. Active learning methodologies require the student to actively search for knowledge, integrate theory with practice, work in groups and develop critical thinking. These peculiarities place the student at the centre of the teaching-learning process, favour the development of self-confidence, improve communication skills and the awareness of their limitations and needs and implement decision-making competence (3).

Among the recently most used active learning methods in nursing education, we can find the Flipped Classroom Model (3-4). According to this instructional strategy, before class, students learn the subject and then return to class to apply this knowledge to real-life and problem-solving scenarios. In a recent systematic review by Ozbay et al. (5), the analysis of 24 studies involving more than 2000 nursing students showed that the use of the Flipped Classroom method significantly enhanced students' skill competence and increased their motivation and interactions.

Team-based Learning (TBL) is a student-centred active teaching method developed by Professor Larry Michaelsen in the United States during the 1980s (6). Since then, TBL has been used across multiple disciplines, including nursing and proved to be effective in achieving undergraduate nursing students' learning outcomes (7,8). This instructional strategy supports the flipped classroom method because students are asked to learn the primary course content before class and spend class time working in teams to apply that content to specific problems (9).

In March 2020, as a result of the COVID-19 pandemic, many nursing students around the world had to witness a sudden transition from conventional face-to-face (F2F) TBL to online TBL.

Despite a large amount of literature on F2F TBL, little has been written on the online conduct of TBL (10). In the last two years, after the COVID-19 advent, some studies on the application of TBL online have been published with the intent to describe how the TBL methodology was implemented in a virtual setting and to suggest some facilitation practices (11-13). Many advantages and some limitations in conducting TBL sessions online have been identified. The online TBL is more accessible and flexible and it allows to provide highly differentiated study materials and record sessions (10,11). However, there may be challenges in monitoring students' engagement, communicating with them, being proficient in the use of online platforms and managing connectivity issues (10-12,14).

Some studies have investigated different outcomes associated with the implementation of online TBL, such as student perceptions, engagement or satisfaction, through the use of online surveys or structured feedback forms specifically designed (15,16). Only rarely had the instrument undergone some form of validation (14).

Aims

The main aim of this study is to examine the performance of students in tRAT and iRAT during online TBL. The secondary aims are to evaluate the students' attitudes toward online TBL and their accountability, preferences and satisfaction with this educational strategy.

Methods

The study employed a one-group pretest-posttest quasi-experimental design. A convenience sampling of first-year undergraduate nursing students at the Nursing Degree of Imola, University of Bologna, Italy, was used. They attended nine online TBL sessions in the Clinical nursing course from December 2020 to March 2021 during the 2020/21 academic year.

An overall of TBL sessions' topics is listed in Table 1. As this was the students' first experience of

Table 1. Topics of the online TBL sessions.

n	TBL topic
1	Team-based learning teaching strategy
2	The concept of health and its determinants
3	Nursing responsibility
4	Fall assessment and prevention
5	Activities of daily living
6	Acute mental confusion
7	Oxygen therapy
8	Catheter-associated urinary tract infections
9	Catheter-related bloodstream infections

TBL, to familiarize themselves with it, the first TBL session concerned the teaching methodology itself (10).

Online Team-Based Learning implementation

In the interest of maintaining the integrity of TBL in an online environment, the researchers followed the principles described in the latest version of the Best Practice guidelines prepared by the Team-Based Learning Collaborative (TBLC) (17).

According to these guidelines, orientation, readiness assurance process, application exercises and peer evaluation represent critical components that must be handled also in an online learning context.

Team formulation is a key component of online TBL orientation: students should be assigned to teams using a process that ensures that each team has as much diversity as possible (eg. background knowledge, gender mix…) (5). In our study, the grade achieved at the University admission test was used to distribute the students across 12 different groups of 5-6 students each. Furthermore, to enhance team dynamics, continuity of learning and cohesiveness of teams, students remained in the same group through the entire first year. It allowed students to develop working relationships with teammates and learn interpersonal skills that they can use when working in teams in a clinical setting.

To mimic the TBL methodology in an online setting two platforms were used. The first platform is Microsoft Teams® and it was used to create virtual classes and communicate synchronously with students. The second platform is a Moodle Learning Management System (LMS), already in use at the University of Bologna as a storage platform for learning resources. A TBL facilitator has always been present during the TBL sessions to support the content expert.

The structured format of online TBL implemented in this study is described below.

Pre-class preparation – (1-2 hours)

At least a week prior to the TBL session, students were given the learning outcomes and pre-assigned teaching materials, including slides, readings or videos, to be reviewed in their own time. These materials were uploaded to the LMS platform.

Individual readiness assurance test (iRAT) – (10 minutes)

At the beginning of each online TBL session, the instructors iterated the TBL learning outcomes and then announced the start of the iRAT.

Online iRAT was administered through the activity "Quiz" on the Moodle LMS platform. The test was composed of 10/12 cognitive multiple-choice questions (MCQs) to verify their understanding of the principal concepts reviewed before class. Students were not given the right answers because, in a minute, divided into teams and breakout rooms, they had to answer the same set of questions through a consensus-building discussion. This is the Team Readiness Assurance test (tRAT).

Team readiness assurance test (tRAT) – (20 minutes)

Within each breakout room, the group identified a spokesperson that was commissioned to fill in the tRAT quiz, share his/her screen and submit answers agreed within the group. After a defined timing the open attempts were submitted automatically.

To mimic the IF-AT cards used in F2F TBL, we used the feedback option "Interactive with multiple tries": it allows multiple attempts on the same question with a grade penalty. Students answered the question and clicked the 'Check' button. If the answer was correct they received positive feedback and achieved full grade. If the answer was wrong, the students could click the 'Try again' button to try a new response. Since the multiple-choice

questions had four possible answers, students could try again three times. Once the students had got the question wrong three times, they were just graded wrong with 0 points and advanced to the next question.

As it happens in the F2F TBL, the point allocation served as a motivator to students and allowed the facilitator to track attempts required to answer the question correctly by each group.

Instructor clarification review – (15 minutes)

After the tRAT, data from the quizzes were gathered instantaneously through the informatic system and analyzed in order to give immediate feedback and clarification. The content expert discussed challenging tRAT questions and answered student-generated questions that peers could not answer, before moving to the Team Application phase.

Team application (tAPP) (25 minutes) and class discussion (30 minutes)

Students were sent back to their breakout rooms to complete the Team application exercise in which they were presented with a realistic scenario and challenged to make some specific choices from a range of options using their problem-solving skills.

The spokesperson was in charge of taking note of the answer that was given to each question. When returned to the large group virtual class, the facilitator shared the Team application questions on the screen, one at a time. To reproduce the simultaneous report of the 4 S's principles of the tAPP's structure, the content expert asked each spokesperson to write on the chat of the virtual class, at the same time, the answer given by his/her group reporting the number of the group and the letter of the answer.

Groups of opposing incorrect and correct answers were invited to declare the reasoning for their response. The content expert then provided further discussion points.

Peer evaluation – (5 minutes)

Finally, students were asked to fill out an online peer evaluation which consisted in assigning a score to each of the teammates based on their contribution during TBL.

Survey instruments

The students' attitudes towards TBL, before and after the training intervention, were measured through the anonymous questionnaire designed by Parmelee et al. in 2009 (18). The questionnaire consists of 19 statements with a five-point Likert-type response format ranging from Strongly disagree (= 1) to Strongly agree (= 5). This instrument presents 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.

In addition to this, only after the training intervention, students' accountability, preferences and satisfaction with TBL were collected through the Team Based Learning Student Assessment Instrument (TBL-SAI) (19).

The TBL-SAI represents a valuable 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 scale that is scored from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 =strongly agree). For the reversed items, interval scoring is from 5 to 1.

The TBL-SAI consists of three subscales: accountability (items 1 to 8), preference for lectures versus TBL (items 9 to 24) and student satisfaction (items 25-33).

A higher total instrument score indicates a more positive experience regarding TBL (19). 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 versus TBL and > 27 for the student satisfaction subscale. Permission to use this copyrighted instrument and to publish some selected items in this article were granted by the author herself, Heidi Mennenga.

Both questionnaires were translated into Italian and administered online; participants' anonymity was guaranteed.

Statistical analysis

All statistical analyses were performed using IBM SPSS software (version 27) with a significant level of p<0.05.

The primary outcome of the study was evaluated by comparing the average scores obtained by the students in the tRAT versus the iRAT in each online TBL session using the parametric test of significance t-test.

The internal structure validity of both instruments was evaluated with Cronbach's alpha coefficient.

With regard to the Parmelee et al.'s questionnaire, a t-test was conducted to determine if changes in attitudes about online TBL occurred after the training intervention. Finally, for TBL-SAI, the mean score obtained by the students in each subscales were compared with the neutral values identified by the author of the instrument.

Ethical aspects

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

Results

Fifty-four out of 60 eligible students were recruited for the study. Forty-six (85%) were female and 8 (15%) were male, with an average age of 22.8 ± 5.6 (SD) years.

Primary outcome

A statistically significant improvement was identified in students' performance between tRAT and iRAT in all the nine online TBL sessions (p<0.001), as depicted in Table 2. For the attribution of the scores in the different steps of the online TBL session, in this study, it was adopted the scale of grades commonly applied in the Italian academic environment that sees a range from 0 (minimum) to 30 (maximum; "com laude" was not applied) with a score of 18 that corresponds to the sufficiency.

Secondary outcomes

The survey instruments presented the following internal consistency values (Cronbach's Alpha): $\alpha=0.91$ for Parmelee et al.'s questionnaire and $\alpha=0.76$ for TBL-SAI.

Table 3 depicts the comparison of means and standard deviations for each item in the five categories pre and post intervention of the Parmelee et al.'s questionnaire.

Table 2. Comparison of the mean scores between tRAT and iRAT.

		iRAT	tRAT	
Session	**Students (n)**	**Mean (SD)**	**Mean (SD)**	**p**
TBL 1	48	27.1 (4.1)	30.0 (0.0)	p<0.001
TBL 2	51	26.1 (4.3)	29.7 (0.6)	p<0.001
TBL 3	45	27.1 (3.6)	29.9 (0.3)	p<0.001
TBL 4	48	19.6 (5.0)	27.6 (1.5)	p<0.001
TBL 5	47	23.7 (4.4)	29.0 (0.9)	p<0.001
TBL 6	50	21.2 (6.5)	28.9 (1.3)	p<0.001
TBL 7	49	25.7 (3.9)	29.5 (0.6)	p<0.001
TBL 8	50	23.0 (4.6)	28.6 (0.8)	p<0.001
TBL 9	51	18.9 (5.4)	27.6 (1.3)	p<0.001

iRAT: individual readiness assurance test, tRAT: team readiness assurance test

Table 3. Comparison of the mean scores of the Parmelee at al.'s questionnaire pre and post the TBL sessions

Items	Pre Mean (SD)	Post Mean (SD)	t	p
Overall satisfaction with Team Experience	**3.78 (0.6)**	**4.19 (0.8)**	**3.10**	**0.003**
1. I have found working as part of a team in my classes to be a valuable experience	4.27 (0.73)	4.05 (0.94)	1.28	0.208
2. In most of the teams I have been on, the other team members have generally contributed as much as I have	**3.34** (0.75)	**3.98** (1.05)	-3.63	**<0.001**
3. In most of the teams I have been on, the team has worked well together	**3.39** (0.72)	**4.5** (0.79)	-7.44	**<0.001**
4. In most of the teams I have been on, I felt the other team members respected me	**3.66** (0.86)	**4.52** (0.82)	-5.06	**<0.001**
5. I have found teamwork to be a productive use of course time	4.23 (0.8)	3.91 (1.07)	1.50	0.142
Team Impact on Quality of Learning	3.54 (0.6)	3.41 (0.88)	0.9	0.341
6. I have found that teams help me learn course material more than if I just studied alone	3.66 (0.71)	3.52 (1.05)	0.85	0.402
7. I have learned more in courses where I have been a member if a team	3.48 (0.73)	3.32 (1.05)	0.88	0.384
8. I have found being part of a team improves my course grades	3.48 (0.70)	3.39 (0.95)	0.68	0.499
Satisfaction with Peer Evaluation	3.59 (0.6)	3.38 (0.9)	1.27	0.210
9. I have found that my peers have been fair in judging my contributions to a team	**3.34** (0.65)	**4.02** (0.85)	-4.72	**<0.001**
10. I have found that peer evaluation motivates me to work harder	**3.57** (0.90)	**3.02** (1.19)	2.28	**0.028**
11. I have generally liked the use of peer evaluation as part of my team experience	3.57 (0.85)	3.20 (1.07)	1.75	0.88
12. I have found that peer evaluation motivates me to work more collaboratively	**3.86** (0.82)	**3.27** (1.17)	2.70	**0.010**
Team Impact on Clinical Reasoning Ability	**3.70 (0.6)**	**4.08 (0.8)**	-3.04	**0.004**
13. I have found that being on a team has helped me become better at problem solving	3.84 (0.78)	4.09 (0.98)	-1.64	0.109
14. I have found that teams make good decisions	**3.32** (0.74)	**3.98** (0.88)	-4.06	**<0.001**
15. Being part of a team discussion has improved my ability to think through a problem	3.95 (0.78)	4.16 (0.96)	-1.35	0.183
Professional Development	3.97 (0.67)	3.72 (0.95)	1.95	0.058
16. I have found that working with a team helps me develop skills in working with others	4.27 (0.69)	3.98 (1)	2	0.51
17. I have found that working with a team has helped me develop cooperative leadership skills	3.75 (0.94)	3.73 (1.11)	0.14	0.893
18. I have found that working with a team has helped me develop more respect for the opinions of others	4.11 (0.81)	3.8 (1.25)	1.86	0.70
19. I have found that working with a team has enhanced my sense of who I am	3.73 (0.82)	3.36 (1.28)	1.91	0.62

Data from the Parmelee et al.'s questionnaire showed that significant changes in students' attitudes occurred in the areas of Overall satisfaction with Team Experience, Satisfaction with Peer Evaluation and Team Impact on Clinical Reasoning Ability.

A comparison of overall mean scores for statements in the category "Satisfaction with team experience" showed a statistically significant increase after the online TBL sessions (p=0.003). In particular, students felt to have been respected by the other members of the team and reported a positive impression of working with others.

As concerns peer evaluation, participants considered it to be fair (p<0.001), even though they did not

consider it as a factor encouraging them to be more committed to studying (p=0.028) or collaborating (p=0.010). Finally, data showed a statistically significant increase in overall mean scores in the subscale "Team Impact on Clinical Reasoning Ability" and students felt that being part of a team made them more competent in making the right decisions (p<0.001).

TBL-SAI parameters and results are presented in Table 4. Students' accountability after the TBL implementation increased: it is apparent in the top row of the table where the mean score for the Accountability subscale is higher than the neutral reference value. Similarly, the mean score for the Preference subscale shows that students preferred TBL to frontal lessons. Satisfaction value, instead, was neutral.

Discussion

The main purpose of this paper has been to examine the performance of students in tRAT and iRAT during online TBL. The results indicate that students achieve statistically significant higher scores when they perform the readiness assurance test through a consensus process. It seems reasonable to assume that the improvement from the iRAT and the tRAT hinges on students collaborating with one-another and peer-learning (20,21).

This result is confirmed also by Ngoc et al. (22) in a meta-analysis on students' readiness assurance test performance with TBL that involved 11 studies and 1575 participants. The authors found evidence that groups consisting of only nursing students achieve much higher improvement with the tRAT than with the iRAT compared to other subgroups which included students from different disciplines. A possible explanation for this result might be related to the fact that nursing students often show more positive attitudes toward teamwork than other health care students do (22).

In addition to that, it is worth noticing that, even if in some online TBL sessions the mean grade for the iRAT was not high, as was the case in session n. 4, 5, 6, 8, 9, the mean score for the tRAT has always been very high and above 27 out of 30. This may indicate that, not only does collaboration within teams allow for better scores applied to the same questions, but also that it unifies overall performance within the class group. This could depend on team composition: the method used to subdivide students into teams has proved effective in preserving homogeneity among groups (11). In this way, in each team there were students able to obtain excellent individual performances and to convince and positively guide their group towards better scores also at the tRAT.

The secondary aims have been to evaluate the students' attitudes and their accountability, preferences and satisfaction with online TBL through the use of two specific instruments.

Data from the Parmelee et al.'s questionnaire showed that the implementation of this new teaching strategy in an online setting has increased their satisfaction with working in teams. We speculate that this positive perception might depend on the fact that TBL has represented one of the few occasions for our students to communicate actively and engage with other classmates during the COVID-19 pandemic. It is because, at the time this study was conducted, the participants attended their lessons online. Since our curriculum is still dominated by teacher-centered lectures, the ability to interact with each other and collaborate was limited.

In terms of peer evaluation, students felt they have been judged fairly by their teammates. Nevertheless, the results seem to indicate that this important phase of TBL structure did not succeed in one

Table 4. Results from the TBL-SAI.

Subscale	Number of items	Possible score range	Neutral*	Mean (SD)
Accountability	8	8-40	24	**30 (3.7)**
Preference	16	16-80	48	**51.8 (6.3)**
Satisfaction	9	9-45	27	**27.9 (5)**
Overall	33	33-165	99	**109.7 (10.8)**

of its main outcomes, which is incentivizing students to positively contribute to group learning (23). Peer assessment, indeed, keeps students accountable to their teammates concerning pre-class preparation and contribution to the interpersonal group dynamics and team productivity (24). In our study, instead, the mean scores for the statements "I have found that peer evaluation motivates me to work harder" and "I have found that peer evaluation motivates me to work more collaboratively" decreased after the TBL implementation. Previous studies have demonstrated that many students are resistant to peer evaluation (18,25) and that students need adequate training to understand the process of feedback (26). These findings are similar to those of Govindarajan and Rajaragupathy in their study on teaching Biochemistry for medical students through an online TBL (16). The items of their instrument regarding receiving constructive feedback from peers had the least mean scores. It seems reasonable to assume that peer evaluation represents a complex skill that still needs to be developed in our students.

Our students' perception of team impact on their clinical reasoning ability showed a statistically significant increase after the online TBL implementation. Even though all the items in this category received a higher mean score after the online TBL experience, only one of them achieved statistical significance. In literature, there are contrasting results on problem solving and critical thinking skills as learning outcomes of TBL (7). However, Sannathimmappa et al. (14), in their study on the effectiveness of an online synchronous TBL for medical students, found out that 89.7% of the participants believed that TBL had increased their problem-solving ability. Our students felt that their teams were able to make the right decisions. A potential explanation for this result might be related to the findings of the primary outcome of the study. As stated before, the performances achieved by teams during tRAT were excellent and this may have given the students the feeling of being effective in making the right choices while collaborating during the TBL sessions.

The results from the TBL-SAI in the Accountability and Preference subscales have been higher than their neutral values. On the other hand, data from the Satisfaction subscale fell in the "mixed-opinion" range.

Accountability subscale assesses student's preparation for class and their contribution to the team; preference subscale assesses student ability to recall material and student attention level in lecture and TBL (19).

To date, there is limited evidence on students' accountability evaluation in online TBL. Our result is consistent with Arcila Hernández et al.'s study on the implementation of TBL in the life sciences (11). Their experience transitioning to distance learning during the pandemic confirmed that the use of online TBL can increase student accountability, in particular by reason of the use of small progressive assignments. Wong et al., to hold students accountable for their learning during the team application phase of online TBL, used to randomly call upon any student to respond or defend their team's answer (12). It ensured that the students kept up with the discussion and that peer learning had occurred within the team. In our study, this strategy to promote student's accountability has been used to a limited extent and, on most occasions, it was the spokesman who justified the group's choices. Nevertheless, our students felt a greater sense of accountability after the TBL implementation. This result probably reflects the efforts that have been made to respect the basic elements of TBL also in the online environment. In addition, the grading of TBL sessions was weighted as 5% of the assessment plan in the nursing course. Since the overall TBL grade was divided in iRAT 25%, tRAT 35%, tAPP 35% and peer evaluation 5%, students were empowered to study pre-class and collaborate within the group.

Anyway, previous studies in which the TBL-SAI was used to assess students's opinions of face-to-face TBL reported an increased level of accountability and preference to frontal lesson in different disciplines: nursing (19,27), pharmacy (28-30), medicine (21,31), occupational therapy (32), physiotherapy (33-35), non-medical healthcare students (36).

Interestingly, data from the satisfaction subscale, which assesses student satisfaction with TBL (19), are neutral. Previous research has shown mixed results on TBL satisfaction. Although in most studies, students were satisfied with TBL (21,32-35,39), in other studies the opinion was different.

In literature, several reasonable justifications have been hypothesized to this result. In 2013, Fatmi et al. (37) supposed that students' reaction to TBL could be negatively influenced by the increased workload (e.g. required advanced readings and preparation) and shift in culture toward peer assessment and accountability. Sharma et al. (29) identified two possible reasons: the short duration of TBL use that may not have given students enough time to form an opinion; and the fact that there have been some problems with the timing of the TBL session components, caused by lack of experience of instructors. Lubeck et al. (38) underlined the importance of having adequate time to get the students accustomed to TBL and the required level of responsibility, otherwise instructors could face some resistance.

In our study, we suppose that the "neutral satisfaction" with TBL might depend on two main factors. Firstly, online team-based learning deviates from the traditional teacher-centered lecture format that our students typically experience. Students may find it difficult to adapt to the flipped classroom approach. Secondly, this was the first implementation of online TBL into our curriculum. We cannot rule out the possibility that the students' attitudes were affected by the newness of the instructional approach as well as the challenges for faculty in adapting the online TBL strategy to their courses.

Conclusions

One of the most important factors for successful learning outcomes in higher education is matching the learning preferences of students with the instructional strategies used by educators (1). Although accustomed to intrapersonal learning, generation Z students consider peers as valuable resources and desire working with others, often after having faced a problem on their own (1). They appreciate being presented with clinical problems that stimulate thinking and problem-solving, also in the online environment (39). These characteristics and preferences fit nicely with the flipped classroom approach (1) and TBL, both F2F and online.

Our study shows that the institutional restrictions due to the COVID-19 pandemic may not be an obstacle to conducting student-centered active learning programs in nursing education. Our findings show that online TBL represents a valid alternative for fostering students' competencies development in nursing academic education. Teamwork improves the group performance compared to individual results and is appreciated by the participants. In addition, the online TBL has a positive effect on the accountability of students who prefer it to frontal lectures. To our knowledge, this is the first study of online TBL among nursing students in Italy.

The results of this study should be seen in light of some limitations. Firstly, this is a single centered study with a small convenience sample size; hence, the results of the study cannot be generalized. Secondly, the Parmelee et al's questionnaire and TBL-SAI are self-report tools that have been created to assess students' attitudes and opinions on F2F team-based learning, not online TBL. Lastly, in the virtual setting, it has been difficult to monitor students' interactions into the breakout rooms, as well as verifying that they were not sharing responses during iRAT.

Further experimental studies with a larger sample size and multicentric are needed to compare the outcomes between F2F and online TBL. In addition, to assess whether student satisfaction with online TBL could progressively improve over time, prospective studies will be required.

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