

Advancing Health Workforce Education: Development and Psychometric Validation of the Challenges in Team-Based Learning Questionnaire (CTBLQ) in Vietnam

Pham Thi Kien¹, Leslie F. Lazaro²

¹Dong A University, Da Nang, Vietnam

²St. Luke's College of Nursing, Trinity University of Asia, Quezon City, Philippines

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ABSTRACT

Although Team-Based Learning (TBL) is widely adopted in health professions education to strengthen collaborative competencies, instruments specifically designed to identify barriers to its implementation remain limited, particularly in transitioning educational contexts. This study aimed to develop and psychometrically validate the Challenges in Team-Based Learning Questionnaire (CTBLQ) among undergraduate nursing students in Vietnam. A methodological research design was employed involving 280 undergraduate nursing students selected through stratified simple random sampling. The 18-item questionnaire underwent expert content evaluation and linguistic review before reliability testing and exploratory factor analysis. The CTBLQ demonstrated excellent internal consistency (Cronbach's $\alpha = 0.910$), and all corrected item–total correlations exceeded the recommended threshold of 0.30. Sampling adequacy was confirmed by a Kaiser–Meyer–Olkin value of 0.853, while Bartlett's test of sphericity was statistically significant ($\chi^2(153) = 4098.257, p < 0.001$). Exploratory factor analysis supported a three-factor structure explaining 68.10% of the total variance, comprising learning preparation, participation, and motivation challenges; interpersonal and social conflict challenges; and learning benefit and team harmony challenges. Overall, the CTBLQ demonstrated satisfactory psychometric properties and provides a standardized diagnostic instrument for identifying barriers to Team-Based Learning implementation. The instrument may support evidence-informed curriculum evaluation, educational planning, and future research in nursing education while contributing to the advancement of health workforce education through improved implementation of collaborative learning.

Keywords: Team-Based Learning, Nursing Students, Psychometric Validation, Questionnaire Development, Nursing Education, Vietnam



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Corresponding Author:

Pham Thi Kien

Dong A University, 33 Xo Viet Nghe Tinh Street, Hoa Cuong Ward, Da Nang City, Vietnam

Email: kienpham.hk.2201@gmail.com

1. INTRODUCTION

Globally, health professions education has shifted from teacher-centred, lecture-based instruction toward competency-based, learner-centred, and collaborative educational approaches that emphasize interprofessional learning and active engagement (Hill et al., 2021; Imanipour et al., 2022; Ulfa et al., 2021). This transformation is driven by the escalating complexity of modern clinical settings, which demand that nursing graduates possess robust capabilities in critical thinking, collaborative problem-solving, professional communication, and sound clinical decision-making (Almarwani & Alzahrani, 2023; Yeung et al., 2023). To bridge the gap between theoretical knowledge acquisition and authentic clinical practice, Team-Based Learning (TBL) has increasingly been adopted as an evidence-based active-

learning strategy in nursing education, fostering collaborative knowledge application and clinical reasoning (Alberti et al., 2021; Alizadeh et al., 2024; Burgess et al., 2020). Structurally anchored around pre-class preparation, readiness assurance tests, immediate feedback, and application-focused exercises, TBL fosters classroom accountability and collective decision-making (Alizadeh et al., 2025; Mansoor et al., 2026). Empirical evidence consistently indicates that well-executed TBL interventions significantly enhance nursing students' academic engagement, clinical reasoning, and generic teamwork capabilities (Sterpu et al., 2024; Zhang et al., 2023).

Paradoxically, while the pedagogical benefits of TBL are extensively documented, its operational implementation is highly susceptible to multi-faceted student-level and group-level barriers (Alexander et al., 2024; Burton et al., 2024). Prior studies note that the collaborative efficacy of TBL can be compromised by systemic challenges, including disparate pre-class preparation, uneven distribution of task completion, time management constraints, motivational deficits, and acute interpersonal or personality conflicts (Burgess et al., 2020; Dnyanesh et al., 2024; Roossien et al., 2025; Yeung et al., 2023). In the context of health workforce education, the urgency of isolating and addressing these negative variables cannot be overstated. Undetected or poorly managed challenges within student teams do not merely cause temporary dissatisfaction; mechanistically, they foster social loafing, heighten student anxiety, and catalyze team dysfunction. Consequently, these unresolved barriers undermine core competencies such as mutual respect, shared leadership, and cooperative communication that are strictly required for safe interprofessional practice in healthcare environments.

The necessity of mitigating these learning barriers is particularly acute in developing Southeast Asian countries such as Vietnam, where health professions and nursing education are undergoing extensive competency-based curriculum reforms aimed at strengthening clinical competence, self-directed learning, and professional practice (Nguyen et al., 2022; Tran et al., 2022). Historically, the Vietnamese educational landscape has been characterized by teacher-centred instructional traditions rooted in sociocultural norms, where students have typically assumed relatively passive learning roles and regarded teachers as the primary authority, shaping enduring learning habits and strategies (L. Ho & Dimmock, 2023; T.-T.-T. Ho & Oh, 2022; Phuong et al., 2020). When abruptly transitioned into the high-accountability, active-discussion environment of TBL, Vietnamese nursing students encounter distinctive socio-cultural and psychological friction. Governed by traditional communicative norms that emphasize rigid institutional hierarchy and the overarching preservation of group harmony, these students often experience heightened anxiety when forced to engage in peer evaluation, voice critical dissent, or navigate gender- and regional-background differences during team assignments. Although preliminary regional evidence indicates that TBL has the potential to boost classroom engagement in Vietnamese nursing schools, the specific, culturally nuanced barriers confronting these students during this educational transition remain empirically unmapped (Ngoc et al., 2024).

Crucially, addressing these educational barriers requires methodologically rigorous tools; however, a significant gap persists within current nursing research methodologies. The predominant repository of globally utilized TBL assessment instruments, most notably the Team-Based Learning Student Assessment Instrument (TBL-SAI), is designed to measure positive educational outcomes, including students' accountability, preference for Team-Based Learning over traditional lectures, and satisfaction with the learning experience, rather than identifying barriers to TBL implementation (Alberti et al., 2021; Considine et al., 2021). Assessment frameworks that focus solely on positive outcomes fail to provide a diagnostic lens into the multidimensional challenges that hinder effective team performance. Consequently, without a psychometrically sound and contextually appropriate instrument supported by robust evidence of validity and reliability, nurse educators lack dependable empirical data to accurately diagnose barriers and guide evidence-based educational interventions (Filomeno et al., 2026; Mikkonen et al., 2022; Williams et al., 2025). This absence of valid diagnostic measurement tools may lead instructional interventions, curriculum improvement initiatives, and faculty development efforts to rely on assumptions or anecdotal judgments rather than objective empirical evidence, thereby limiting the effectiveness of targeted educational reforms (Ing et al., 2021; Khan et al., 2021).

To bridge this empirical and methodological void, this study aimed to develop and evaluate the psychometric properties of the Challenges in Team-Based Learning Questionnaire (CTBLQ) among undergraduate nursing students in Vietnam. By establishing a reliable, valid, and structurally sound diagnostic scale based on rigorous instrument-development protocols, this research seeks to advance health workforce education. Ultimately, this tool intends to provide educators with the requisite empirical infrastructure to systematically diagnose operational barriers, optimize active-learning design, and strengthen the collaborative readiness of future healthcare professionals.

2. METHOD

2.1. Study Design

Methodological studies are designed to develop new measurement instruments and to systematically evaluate their psychometric properties before their application in research and practice (Elsman et al., 2024; Mikkonen et al., 2022; Mikkink et al., 2024; Swan et al., 2023). This investigation employed a

methodological research design to develop and systematically evaluate the psychometric properties of the Challenges in Team-Based Learning Questionnaire (CTBLQ) among undergraduate nursing students in Vietnam. The present manuscript was derived from a larger research project investigating teamwork capabilities, operational barriers, and the multifaceted dynamics of Team-Based Learning (TBL) in undergraduate nursing education. Whereas the parent study adopted a descriptive correlational design to examine students' teamwork-related outcomes, the present study reports the methodological phase of the project, focusing on the development and psychometric evaluation of the CTBLQ, including item generation, content validity, internal consistency reliability, and construct validity. This methodological approach was undertaken to establish evidence supporting the validity and reliability of the instrument before its application in subsequent studies of nursing and health professions education.

2.2. Participants and Setting

The empirical study was executed at a selected university in Vietnam that provides an established bachelor's degree program in nursing education. The target population for this psychometric evaluation comprised second, third, and fourth-year undergraduate nursing students who possessed direct experience with collaborative teamwork activities and Team-Based Learning modalities in their academic curriculum. To determine the appropriate sample size for the baseline project, an a priori power analysis was conducted utilizing G*Power software to establish structural stability. The initial statistical power calculation indicated that a minimum sample of 262 participants was required to maintain low estimation errors and secure adequate statistical properties.

To proactively compensate for potential data missingness, incomplete responses, and to maximize the overall structural adequacy of the sample, the final analytical dataset was successfully expanded to include 280 undergraduate nursing students. This expanded sample size was considered highly appropriate and statistically adequate for performing exploratory factor analysis because the final analytic matrix consisted of 18 measurable indicators, thereby yielding a ratio of more than 15 participants per indicator (Gunawan et al., 2021; White, 2022). The recruitment process was strictly governed by a stratified simple random sampling methodology to ensure balanced representation across the different cohorts. The student population was first stratified according to their academic year level to capture unique experiential differences, after which individuals were selected from each stratum using simple random sampling to maintain a strictly proportional representation across all academic levels.

2.3. Instrument Development

The CTBLQ was originally designed to systematically quantify the distinct learning and operational challenges encountered by undergraduate nursing students during the execution of Team-Based Learning activities. The initial item generation pool was derived from a rigorous synthesis of contemporary literature regarding active learning obstacles, alongside the principal researcher's extensive pedagogical background spanning more than 15 years of active teaching experience in nursing education. The baseline conceptual framework of the questionnaire originally comprised 14 core challenge items evenly mapped across five theoretical domains, which were participation, time management, motivation, personality conflicts, and social context. These conceptual domains were chosen because they reflect major dimensions of situational difficulty that directly impair student engagement, collaborative focus, pre-class preparation, group interactions, and overall learning experiences during Team-Based Learning. Within the definitive dataset utilized for this psychometric validation, several core items were operationalized via multiple measurable indicators to fully capture their underlying traits. Consequently, the final analytical version of the CTBLQ incorporated 18 distinct measurable indicators derived from the original 14 items, retaining the original five domains as the core structural framework while using exploratory factor analysis to systematically reveal the underlying empirical structure.

2.4. Content Validity by Expert Panel

The content validity of the preliminary CTBLQ was evaluated by a dedicated panel of five independent experts possessing diverse academic, clinical, educational, and research expertise in healthcare sciences. The multidisciplinary panel specifically included a PhD expert in clinical psychiatry and psychology, a PhD specialist in nursing education, a physician holding a PhD in nursing with extensive practical experience applying Team-Based Learning, a PhD administrator responsible for the university Scientific Research Office, and a PhD authority in educational management. These evaluators systematically scrutinized the questionnaire items regarding their individual relevance, structural clarity, linguistic appropriateness, and overall representativeness for measuring active learning challenges. The expert panel review fully supported the content validity of the scale prior to its deployment in the primary data collection phase. Quantitatively, the calculated content validity index values for the five original subscales demonstrated highly acceptable properties, yielding indices of 0.795 for participation, 0.764 for time management, 0.749 for motivation, 0.827 for personality conflicts, and 0.830 for social context.

2.5. Translation Validation and Pilot Testing

To ensure the instrument was culturally and linguistically appropriate, a formal translation validation process was executed completely independently from the expert content validation panel. This process aimed to secure maximum linguistic clarity, exact semantic equivalence, and contextual appropriateness of the questionnaire items for Vietnamese nursing students. The translation review team comprised a Vietnamese Master of English, a senior fourth-year nursing student highly familiar with teamwork skills and Team-Based Learning frameworks, and a bilingual Vietnamese-American medical physician. This collaborative validation process effectively ensured that the questionnaire wording was perfectly understandable, culturally sensitive, and aligned with the original conceptual meaning of the challenge indicators. Prior to launching the primary survey, a pilot test was conducted among 50 nursing students who shared identical target characteristics but were excluded from the final analytic sample. This pilot study confirmed the operational feasibility of administration, verified item clarity, and demonstrated strong preliminary reliability with a calculated Cronbach's alpha coefficient of 0.829.

2.6. Scoring Procedure and Data Collection

The CTBLQ utilized a standard five-point Likert response scale where options ranged from 1 indicating rarely to 5 indicating always. Because several indicators within the questionnaire were formulated as positive expressions, a mathematical reverse-scoring transformation was applied before performing psychometric analysis to ensure uniform directional alignment. All 18 measurable indicators were transformed using the standard mathematical formula where the reversed score equals six minus the original score. Following this reverse-coding procedure, higher calculated scores linearly reflected a greater level of perceived challenges and systemic barriers encountered during Team-Based Learning sessions. This scoring process permitted both the total scale and individual factor scores to be interpreted consistently across the sample. The primary data collection was carried out utilizing a self-administered questionnaire framework where eligible nursing students were fully briefed on the study goals and invited to participate on a voluntary basis. While the survey instrument comprehensively captured demographic characteristics, teamwork skills, perceived challenges, and students' assessment of Team-Based Learning, only the demographic variables and the specific CTBLQ data were subjected to empirical analysis for the present manuscript within a completely coded and anonymized framework.

2.7. Data Analysis

The statistical data analysis followed a stepwise psychometric approach to evaluate the structural integrity of the CTBLQ. The dataset was first examined for completeness, coding accuracy, missing values, and responses outside the expected 1–5 Likert-scale range. Descriptive statistics, including means and standard deviations, were calculated for all 18 items, together with domain and total scale scores after reverse coding. Internal consistency reliability was assessed using Cronbach's alpha, whereas corrected item–total correlations and Cronbach's alpha if item deleted were calculated to evaluate the contribution of individual items to the overall scale. Corrected item–total correlation coefficients of ≥ 0.30 were considered indicative of acceptable item discrimination.

Prior to exploratory factor analysis (EFA), sampling adequacy was evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. A KMO value > 0.60 together with a statistically significant Bartlett's test indicated that the correlation matrix was suitable for factor analysis. Exploratory factor analysis was then performed to examine the underlying construct validity of the CTBLQ. Factors with eigenvalues greater than 1.0 were retained, and items with factor loadings ≥ 0.40 were considered acceptable. The final factor solution was determined by considering eigenvalues, cumulative explained variance, factor loadings, the absence of substantial cross-loadings, internal consistency reliability, and conceptual interpretability.

2.8. Ethical Considerations

Ethical approval for the parent research project, including the study protocol, survey instruments, and data collection procedures, was obtained from the Institutional Ethics Review Committee of Trinity University of Asia (Protocol No. 2024-2nd-CNU-Pham-v2; approved on 3 July 2024). The study was conducted in accordance with the ethical principles of respect for persons, beneficence, and justice. Participation was voluntary, and all participants received information regarding the study objectives, confidentiality of their responses, and their right to decline participation or withdraw at any time without academic consequences. Written informed consent was obtained from all participants prior to data collection. All study data were de-identified before analysis, and no personally identifiable information was included in the dataset or the final report.

3. RESULTS

3.1. Demographic Profile of the Participants

The comprehensive evaluation of the psychometric properties of the instrument began with a detailed analysis of the demographic characteristics of the sample to ensure appropriate data

diversification and representativeness. A total of 280 undergraduate nursing students successfully completed the self-administered survey within the selected Vietnamese university setting. The gender distribution within the cohort revealed a substantial female dominance, with female students accounting for 91.4% of the sample, while male students represented only 8.6% of the total population. This pronounced gender disparity accurately reflects the historical and contemporary demographic trends observed within the nursing workforce and professional nursing education programs across Vietnam. In terms of age distribution, the participants ranged from 20 to 28 years old, which captured a diverse spectrum of young adult learners entering the healthcare profession. The descriptive metrics concerning the comprehensive participant profile are formally detailed in Table 1.

Table 1
Characteristics of the Participants (n = 280)

Profile Characteristics	Category	n	Percent (%)
Age	20	95	33.93
	21	19	6.79
	22	53	18.93
	23	33	11.79
	24	15	5.36
	25	10	3.57
	26	19	6.79
	27	22	7.86
	28	14	5.00
Sex	Male	24	8.60
	Female	256	91.40
Year level	Second year	112	40.00
	Third year	89	31.80
	Fourth year	79	28.20

Further examination of the chronological data indicated that the largest age cohort among the respondents was composed of individuals who were 20 years old, representing 33.93% of the sample. This major group was followed sequentially by students who were 22 years old at 18.93% and those who were 23 years old at 11.79%, demonstrating a steady progression of traditional university-aged learners. Crucially, the dataset displayed a balanced structural representation across the different academic strata because the participants were recruited using a stratified simple random sampling methodology. Specifically, second-year students constituted the largest academic cohort with 40.0% of the sample, while third-year and fourth-year students accounted for 31.8% and 28.2% of the final analytical pool respectively. This robust academic distribution confirms that the captured perspectives span the entire trajectory of the undergraduate nursing program, thereby providing a comprehensive overview of team-based learning experiences from foundational coursework to advanced clinical preparation.

3.2. Item-Level Descriptive Statistics of the CTBLQ

Following the demographic profiling, a comprehensive item-level descriptive analysis was conducted to examine the response distribution across all 18 measurable indicators of the CTBLQ after executing the mathematical reverse-scoring transformation. This initial statistical evaluation is highly instrumental in identifying which specific team-based learning barriers are most prominently or least frequently experienced by nursing students within the Vietnamese educational context. The descriptive metrics, which encompass the calculated mean values, standard deviations, and corresponding categorical interpretations for each individual indicator, are systematically summarized in Table 2. The implementation of this scoring adjustment ensures that higher calculated mean values consistently reflect a greater intensity of perceived difficulty or operational barriers encountered during collaborative learning sessions.

Table 2
Descriptive Statistics of the CTBLQ Indicators after Reverse-Coding (n = 280)

Item	Indicator	Mean	SD	Interpretation
B3.1	Unequal pre-class preparation among team members	2.11	0.91	Sometimes
B3.2	Uneven level of careful preparation before class	2.01	0.83	Sometimes
B3.3	Inequity in assignment distribution by the instructor	1.71	0.76	Rarely
B3.4	Difficulty managing time to complete team assignments	1.90	0.80	Sometimes
B3.5	Uneven performance in completing team assignments	1.83	0.70	Sometimes

B3.6	Difficulty completing homework well	1.92	0.77	Sometimes
B3.7	Lack of enjoyment in team-based learning activities	1.99	0.84	Sometimes
B3.8.1	Team activities do not reduce anxiety	2.13	0.92	Sometimes
B3.8.2	Limited opportunity to express personal viewpoints	1.95	0.84	Sometimes
B3.8.3	Limited stimulation of self-discovery and exploration	1.91	0.86	Sometimes
B3.8.4	Limited improvement in problem-solving ability	1.86	0.77	Sometimes
B3.8.5	Limited deeper understanding of learning issues	1.86	0.82	Sometimes
B3.9	Personality conflicts among team members	2.80	1.16	Often
B3.10	Lack of mutual support among team members	2.09	0.84	Sometimes
B3.11	Conflicts in team assignment distribution	2.65	1.27	Often
B3.12	Inequality or disharmony among team members	1.93	0.81	Sometimes
B3.13	Gender-related conflicts in team assignment	2.40	1.28	Sometimes
B3.14	Regional-background conflicts among team members	2.39	1.35	Sometimes

Note. Mean score ranges are interpreted as follows: 1.00–1.80 = Rarely, 1.81–2.60 = Sometimes, 2.61–3.40 = Often, 3.41–4.20 = Usually, and 4.21–5.00 = Always.

As detailed in the empirical matrix, the computed mean scores for the 18 indicators spanned from 1.71 to 2.80, demonstrating that the nursing students generally encountered these active learning challenges at a moderate to low frequency. A closer inspection of the dataset revealed that only two specific indicators were statistically interpreted as occurring with a relatively high frequency of often. Specifically, indicator B3.9 regarding personality conflicts among team members generated the highest overall challenge score, closely followed by indicator B3.11 which captures explicit conflicts in team assignment distribution among the peers. Conversely, the lowest mean score was recorded for indicator B3.3 concerning perceived inequity in assignment distribution by the instructor, which was categorically interpreted as rarely. The remaining 15 indicators all fell within the boundaries of the sometimes category, highlighting that while logistical and minor interpersonal friction exists within student groups, structural educational biases from the facilitating faculty are seldom encountered as primary barriers.

3.3. Item Analysis and Internal Consistency Reliability

To ensure the individual psychometric contribution of each measurable indicator and evaluate the overarching stability of the developed scale, a rigorous item analysis and internal consistency assessment were executed. The primary examination focused on the item-rest correlation coefficients to confirm that every indicator accurately reflected the underlying construct of team-based learning challenges. Statistical analysis revealed that the item-rest correlation values for all 18 indicators ranged from 0.462 to 0.738, thereby comfortably exceeding the established critical psychometric threshold of 0.30. Consequently, the total questionnaire achieved an excellent overall Cronbach's alpha coefficient of 0.910, confirming high internal consistency and strong scale homogeneity. The detailed empirical outcomes concerning the individual indicator metrics are presented systematically in Table 3.

Table 3
Item Analysis and Internal Consistency of the CTBLQ (n = 280)

Item	Mean	SD	Item-rest correlation	Cronbach's alpha if item deleted	Decision
B3.1	2.11	0.91	0.510	0.907	Retained
B3.2	2.01	0.83	0.622	0.904	Retained
B3.3	1.71	0.76	0.640	0.904	Retained
B3.4	1.90	0.80	0.706	0.903	Retained
B3.5	1.83	0.70	0.723	0.903	Retained
B3.6	1.92	0.77	0.568	0.906	Retained
B3.7	1.99	0.84	0.655	0.904	Retained
B3.8.1	2.13	0.92	0.626	0.904	Retained
B3.8.2	1.95	0.84	0.738	0.901	Retained
B3.8.3	1.91	0.86	0.718	0.902	Retained
B3.8.4	1.86	0.77	0.564	0.906	Retained
B3.8.5	1.86	0.82	0.502	0.907	Retained
B3.9	2.80	1.16	0.462	0.910	Retained
B3.10	2.09	0.84	0.589	0.905	Retained
B3.11	2.65	1.27	0.483	0.910	Retained
B3.12	1.93	0.81	0.521	0.907	Retained
B3.13	2.40	1.28	0.529	0.908	Retained
B3.14	2.39	1.35	0.553	0.908	Retained

Note. Overall Cronbach's alpha = 0.910. Item-rest correlation refers to the correlation between each item and the total score computed from the remaining items.

Further evaluation of the individual items through the Cronbach's alpha if item deleted metric demonstrated that removing any single indicator would not substantially increase the total scale reliability. The calculated alpha values when an item was hypothetically omitted fluctuated narrowly between 0.901 and 0.910, which statistically justified the structural decision to retain all 18 indicators in the final analytical version of the instrument. Beyond the macro-level analysis, it was essential to evaluate how internal consistency behaved when comparing the initial theoretical framework against the newly derived empirical structure. This comparative reliability analysis across the original five content domains and the three final empirical dimensions is summarized comprehensively in Table 4.

Table 4
Reliability Coefficients of the CTBLQ Domains and Final Factors (n = 280)

Scale / Domain / Factor	Number of indicators	Cronbach's alpha	Interpretation
Original content domains			
Participation	3	0.821	Good
Time Management	3	0.815	Good
Motivation	6	0.865	Good
Personality Conflicts	3	0.757	Acceptable
Social Context	3	0.813	Good
Final empirical factors			
Factor 1: Learning Preparation, Participation, and Motivation Challenges	10	0.936	Excellent
Factor 2: Interpersonal and Social Conflict Challenges	5	0.856	Good
Factor 3: Learning Benefit and Team Harmony Challenges	3	0.857	Good
Total CTBLQ scale	18	0.910	Excellent

Note. Cronbach's alpha values were interpreted as follows: ≥ 0.90 = excellent, 0.80 – 0.89 = good, and 0.70 – 0.79 = acceptable.

As shown in the comparative reliability matrix, the coefficients for the five original theoretical domains exhibited acceptable to good internal consistency, with values extending from 0.757 for personality conflicts to 0.865 for motivation. Crucially, the final three-factor structure derived from the subsequent exploratory factor analysis demonstrated even more robust psychometric performance. The internal consistency coefficients for these newly extracted empirical dimensions ranged from 0.856 to 0.936, with the first factor capturing learning preparation, participation, and motivation challenges yielding the highest reliability profile. These comprehensive reliability findings reinforce the structural integrity of the empirical dimensions, confirming that the tool serves as a highly dependable diagnostic instrument for evaluating team-based learning barriers.

3.4. Construct Validity via Exploratory Factor Analysis

The construct validity of the CTBLQ was evaluated using Exploratory Factor Analysis to uncover the underlying empirical dimensionality of the 18 reverse-coded indicators. Prior to extracting the latent factors, the suitability of the correlation matrix and the sampling adequacy of the dataset were systematically assessed. The Kaiser-Meyer-Olkin measure of sampling adequacy yielded a value of 0.853, which significantly exceeded the standard recommended threshold of 0.60. Furthermore, Bartlett's test of sphericity demonstrated a highly significant result, $\chi^2(153) = 4098.257$, $p < 0.001$, confirming that the correlation matrix possessed appropriate patterns of correlation for factor extraction. The matrix determinant of 2.887×10^{-7} further supported the absence of extreme multicollinearity within the dataset. The detailed statistical outputs for these suitability tests are presented in Table 5.

Table 5
KMO and Bartlett's Test for Exploratory Factor Analysis (n = 280)

Test	Value
Number of participants	280
Number of CTBLQ indicators	18
Kaiser–Meyer–Olkin measure of sampling adequacy	0.853
Bartlett's test of sphericity, χ^2	4098.257
Degrees of freedom	153
p-value	< 0.001
Determinant of correlation matrix	2.887×10^{-7}

Following the confirmation of data suitability, principal component extraction combined with an orthogonal rotation strategy was applied to evaluate the structural configuration of the instrument. Based on the Kaiser criterion of retaining factors with eigenvalues greater than one, a definitive three-factor solution was extracted from the matrix. The identified three-factor model accounted for a substantial 68.10% of the total cumulative variance, which meets the standard requirements for instrument validation in social sciences. Factor 1 explained the largest proportion of variance at 44.19% with an eigenvalue of 7.954, followed by Factor 2 explaining 14.73% with an eigenvalue of 2.651, and Factor 3 explaining 9.19% with an eigenvalue of 1.654. The comprehensive factor loading matrix and the final empirical assignment of each indicator are detailed in Table 6.

Table 6
Exploratory Factor Analysis and Final Factor Structure of the CTBLQ (n = 280)

Item	Factor 1	Factor 2	Factor 3	Final factor assignment
B3.1	0.713	0.083	-0.010	Factor 1
B3.2	0.727	0.194	0.072	Factor 1
B3.3	0.769	0.088	0.187	Factor 1
B3.4	0.806	0.149	0.199	Factor 1
B3.5	0.793	0.059	0.387	Factor 1
B3.6	0.722	0.169	0.003	Factor 1
B3.7	0.736	0.183	0.163	Factor 1
B3.8.1	0.780	0.154	0.065	Factor 1
B3.8.2	0.858	0.088	0.270	Factor 1
B3.8.3	0.831	0.051	0.330	Factor 1
B3.8.4	0.249	0.138	0.871	Factor 3
B3.8.5	0.203	0.089	0.884	Factor 3
B3.9	0.173	0.757	-0.019	Factor 2
B3.10	0.279	0.489	0.432	Factor 2
B3.11	0.095	0.812	0.112	Factor 2
B3.12	0.178	0.287	0.719	Factor 3
B3.13	0.082	0.851	0.179	Factor 2
B3.14	0.113	0.861	0.177	Factor 2
Eigenvalue	7.954	2.651	1.654	
Variance explained (%)	44.19	14.73	9.19	
Cumulative variance (%)	44.19	58.91	68.10	
Cronbach's alpha	0.936	0.856	0.857	

Note. Factor loadings ≥ 0.40 were considered acceptable. Factor 1 = Learning Preparation, Participation, and Motivation Challenges; Factor 2 = Interpersonal and Social Conflict Challenges; Factor 3 = Learning Benefit and Team Harmony Challenges.

The factor loading pattern demonstrated clear clustering that allowed for a meaningful naming of the three newly established empirical dimensions. Factor 1 was designated as Learning Preparation, Participation, and Motivation Challenges, containing 10 indicators that reflect primary procedural and motivational barriers during team learning. Factor 2 was labeled Interpersonal and Social Conflict Challenges, which comprised 5 indicators specifically focusing on social demographics and active relationship friction within peer groups. Factor 3 was named Learning Benefit and Team Harmony Challenges, capturing 3 distinct indicators associated with cognitive outtakes and group equilibrium. All 18 indicators displayed robust primary factor loadings well above the acceptable threshold of 0.40, ranging from 0.489 to 0.884, thereby confirming strong construct validity.

A critical methodological evaluation was conducted regarding indicator B3.10 because it exhibited a noticeable cross-loading pattern across two separate dimensions. Specifically, this indicator, which measures the lack of mutual support among team members, generated a primary loading of 0.489 on Factor 2 and a secondary loading of 0.432 on Factor 3. Although the difference between these two loadings was narrow, the structural decision was made to retain indicator B3.10 within Factor 2 based on its higher empirical loading value and its strong conceptual alignment with interpersonal conflicts. Retaining this item ensures the diagnostic capacity of the Interpersonal and Social Conflict Challenges dimension is fully maintained without compromising scale integrity. Ultimately, because no indicators failed to meet the baseline retention criteria or demonstrated uninterpretable cross-loadings, all 18 items were successfully secured in the final definitive version of the CTBLQ.

4. DISCUSSION

4.1. Methodological Rigor and Structural Consolidation of the CTBLQ

The empirical validation of the Challenges in Team-Based Learning Questionnaire (CTBLQ) demonstrated satisfactory methodological rigor and psychometric performance. The preliminary assessment yielded a Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy of 0.853 and a highly

significant Bartlett's test of sphericity ($\chi^2(153) = 4098.257, p < 0.001$), indicating that the correlation matrix was well suited for exploratory factor analysis. In addition, the final sample comprised 280 undergraduate nursing students, corresponding to a participant-to-item ratio of approximately 15.5:1. This ratio exceeds commonly recommended thresholds for exploratory factor analysis and, together with the favorable KMO statistic, supports the adequacy of the sample for stable factor extraction and construct validation (Gunawan et al., 2021; White, 2022). The convergence of these indicators provides robust evidence that the CTBLQ was developed and evaluated using an appropriately powered sample, thereby strengthening the credibility, stability, and interpretability of the resulting factor structure.

A significant psychometric finding of the present study was the structural consolidation of the instrument from an initial five-domain theoretical framework into a definitive three-factor empirical model. Similar structural refinement has been reported in recent psychometric validation studies, in which exploratory factor analysis produced more parsimonious and empirically coherent factor structures than those originally hypothesized during instrument development (Baris et al., 2023; Chair et al., 2023; Kweon & Park, 2023). In the context of health professions education, this empirical consolidation suggests that undergraduate nursing students do not perceive Team-Based Learning (TBL) barriers as rigid, independent domains. Rather, challenges associated with pre-class preparation, classroom participation, and learning motivation appear to converge into a broader dimension of learning difficulty during active learning implementation. This finding is consistent with contemporary evidence indicating that students' preparation, engagement, motivation, and collaborative participation function as interdependent components of the TBL learning process rather than as isolated educational experiences (Considine et al., 2021; Yeung et al., 2023; Zhang et al., 2023). Consequently, the three-factor solution identified in the present study provides a more parsimonious, empirically supported, and contextually meaningful representation of students' perceived barriers while preserving the pedagogical principles underpinning Team-Based Learning.

The internal consistency analysis further demonstrated the operational reliability of the CTBLQ, yielding an overall Cronbach's alpha coefficient of 0.910, indicative of excellent internal consistency. All 18 indicators demonstrated corrected item-total correlation coefficients ranging from 0.462 to 0.738, reflecting satisfactory item discrimination and homogeneity across the scale in accordance with contemporary recommendations for instrument validation (Stefana et al., 2025). Methodological judgment was also exercised for indicator B3.10, which exhibited a primary loading of 0.489 on Factor 2 and a secondary loading of 0.432 on Factor 3. Despite this modest cross-loading, the indicator was retained within the interpersonal conflict domain because its strongest empirical loading remained on the primary factor and its content was theoretically consistent with the underlying construct. Such decisions are consistent with current psychometric guidance emphasizing that item retention should consider both empirical performance and conceptual interpretability when establishing construct validity (Elsman et al., 2024).

The transparent and systematic reporting of the CTBLQ psychometric properties enhances the methodological credibility of the instrument and aligns with current recommendations for rigorous instrument development and validation in health research (Stefana et al., 2025). Unlike general course evaluations or non-standardized educational feedback approaches, the CTBLQ provides a standardized and psychometrically validated framework for assessing barriers to Team-Based Learning. This standardized measurement approach facilitates more objective identification of students' learning challenges and enables meaningful comparisons across educational settings. Furthermore, the three-factor structure identified through exploratory factor analysis offers a parsimonious and theoretically coherent framework that is expected to facilitate future applications of the instrument in nursing and health professions education. Ultimately, the availability of a psychometrically validated instrument for assessing barriers to Team-Based Learning offers a valuable methodological foundation for evaluating educational interventions, supporting competency-based curriculum implementation, and informing evidence-based improvements in nursing education (Horii et al., 2021; Muraraneza & Mtshali, 2021; Nyoni & Goddard, 2021).

4.2. Deconstructing Active Learning Barriers: Preparation, Participation, and Motivation

The empirical extraction of Factor 1, designated as Learning Preparation, Participation, and Motivation Challenges, accounted for the largest proportion of explained variance (44.19%). This foundational dimension comprised 10 measurable indicators and demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of 0.936. The clustering of these indicators suggests that pre-class preparation, time management, and learning motivation are perceived by undergraduate nursing students as interconnected rather than independent challenges. This finding is consistent with contemporary evidence indicating that successful engagement in Team-Based Learning depends on the integration of self-directed preparation, active classroom participation, and sustained learning motivation, with deficiencies in one domain frequently influencing performance in the others (Considine et al., 2021; Yeung et al., 2023; Zhang et al., 2023).

The close association between independent preparation and active group engagement observed in the present study is consistent with contemporary evidence describing Team-Based Learning (TBL) as an integrated instructional strategy in which students' readiness, participation, and collaborative learning operate as interdependent educational processes rather than isolated activities. Systematic reviews have further demonstrated that the effectiveness of readiness assurance activities and collaborative application exercises depends substantially on students' completion of pre-class preparation and their active engagement during team learning (Alberti et al., 2021; Yeung et al., 2023; Zhang et al., 2023). Consequently, inadequate preparation and ineffective time management may diminish students' confidence, classroom participation, and meaningful contribution to collaborative discussions, thereby limiting the effectiveness of Team-Based Learning. The empirical consolidation of these indicators into a single latent factor therefore suggests that learning preparation, classroom participation, and motivation should be understood as closely interconnected dimensions of effective Team-Based Learning implementation rather than as independent educational challenges.

To better understand why these barriers emerged so prominently, the findings should be interpreted within the broader context of ongoing educational reforms in Vietnam. Recent reforms in health professions and nursing education have progressively shifted curricula from traditional teacher-centred models toward competency-based, learner-centred approaches that emphasize self-directed learning, active participation, and clinical competence (Tran et al., 2022). Despite these advances, transitioning from historically lecture-based educational practices to active learning environments requires substantial adaptation by both students and educators, particularly in developing self-directed learning behaviours and collaborative learning skills (Nguyen et al., 2022). This educational transition may partly explain why learning preparation, classroom participation, and motivation emerged as a unified construct in the present study, reflecting the interconnected challenges encountered by undergraduate nursing students during the implementation of Team-Based Learning.

These findings extend the implications of the present investigation beyond psychometric validation by highlighting how student-level barriers may influence the implementation of active learning approaches within nursing education. The identification of preparation, participation, and motivation challenges as an integrated dimension suggests that implementing active learning strategies without first recognizing students' readiness conditions may limit their effective engagement in collaborative learning processes. Therefore, nurse educators should consider addressing these operational challenges through structured readiness support, clear guidance on time management, and strategies that promote sustained student motivation. Ultimately, addressing the vulnerabilities identified within Factor 1 may contribute to more effective curriculum implementation and support the development of collaborative, competent nursing graduates who are better prepared to respond to complex healthcare environments.

4.3. Socio-Cultural Friction and Peer Interpersonal Conflicts

The empirical analysis of Factor 2, identified as Interpersonal and Social Conflict Challenges, provides important insights into the relational dynamics that shape student teamwork within the present Vietnamese nursing education context. Within this dimension, indicator B3.9 regarding personality conflicts among team members and indicator B3.11 concerning difficulties in team assignment distribution received among the highest frequency ratings, suggesting that interpersonal tensions and perceptions of unequal workload allocation represent salient barriers experienced by participants during Team-Based Learning activities. Furthermore, the inclusion of indicators B3.13 and B3.14 within this empirical cluster suggests that variations in students' social backgrounds, including gender-related experiences and regional diversity, may influence perceptions of peer interaction and team collaboration. Therefore, nurse educators should consider the interpersonal and social dimensions of teamwork when designing and facilitating student-led collaborative learning environments.

These empirical outcomes provide a valuable socio-cultural perspective when interpreted alongside contemporary Team-Based Learning literature. Previous studies have highlighted that interpersonal negotiation, peer accountability, and coordination of team responsibilities represent important components influencing students' experiences within collaborative learning environments (Alberti et al., 2021; Considine et al., 2021). However, the expression of these challenges may differ across educational cultures. In nursing education contexts traditionally characterized by hierarchical teacher–student relationships, students may require substantial adaptation when transitioning toward learner-centred approaches that emphasize open discussion, peer feedback, and shared responsibility (Choi & Ahn, 2021; Putri & Sumartini, 2021). Consequently, the interpersonal expectations embedded within Team-Based Learning may create additional adjustment demands, particularly when students must negotiate disagreement, distribute workloads, and provide constructive feedback among peers. This contextual interpretation may help explain why personality conflicts and assignment distribution emerged as prominent operational challenges within the present Vietnamese nursing student cohort.

From the perspective of healthcare leadership and organizational behaviour, the ability to recognize and manage interpersonal challenges during academic training represents an important component of preparing future healthcare professionals. Classroom teams can serve as structured environments in which

undergraduate students develop communication, shared responsibility, negotiation, and collaborative problem-solving skills. Developing these competencies during undergraduate education may facilitate subsequent interprofessional collaboration within clinical settings, where nurses are expected to function effectively within multidisciplinary healthcare teams (Hsieh et al., 2022; James et al., 2022). Therefore, the diagnostic capacity of the CTBLQ may provide educational institutions with an evidence-informed approach to identifying interpersonal barriers and designing targeted strategies that support the development of collaborative readiness and leadership competencies among nursing students.

4.4. The Interplay Between Educational Efficacy and Group Equilibrium

The empirical extraction of Factor 3, designated as Learning Benefit and Team Harmony Challenges, provides insight into the relationship between group relational quality and students' perceived cognitive benefits during Team-Based Learning. This dimension consolidates three measurable indicators and demonstrates satisfactory psychometric properties, with a Cronbach's alpha coefficient of 0.857. The clustering of these items suggests that students' perceptions of limited problem-solving improvement, insufficient deeper understanding of learning issues, and unequal or disharmonious team interactions represent interconnected challenges within collaborative learning environments. These findings suggest that students' perceived learning benefits may be closely associated with the quality of interpersonal relationships and perceived fairness within their teams.

The critical intersection between perceived cognitive benefits and group relational harmony identified in Factor 3 extends current understanding of the conditions influencing Team-Based Learning experiences. Systematic reviews by Alberti et al. (2021) and Zhang et al. (2023) have demonstrated that Team-Based Learning is an effective instructional approach for promoting clinical reasoning, active engagement, and teamwork competencies among health professions students. Furthermore, Yeung et al. (2023) highlighted that structured team discussions may enhance generic capabilities among nursing students, particularly critical thinking and problem-solving skills. However, when this global evidence is considered within transitioning educational contexts, interpersonal friction may create additional pedagogical challenges. A recent quasi-experimental study involving Vietnamese nursing students by Ngoc et al. (2024) demonstrated that although Team-Based Learning can improve student engagement, its educational benefits may depend on the quality of team interactions and collaborative processes. Therefore, disruptions in team harmony or unequal participation may limit students' ability to fully benefit from active learning experiences and achieve the intended cognitive outcomes of Team-Based Learning.

These empirical insights have broader implications for preparing nursing students for safe and effective clinical practice. The development of clinical reasoning, problem-solving competencies, and collaborative skills during undergraduate education represents an essential component of preparing future nurses to respond effectively within increasingly complex healthcare environments (Hsieh et al., 2022; Mikkonen et al., 2022). Because professional nurses are frequently required to engage in complex decision-making and collaborative practice, educational barriers that restrict cognitive engagement and teamwork development may influence students' readiness for future clinical responsibilities (James et al., 2022). Therefore, systematic identification of team-related learning barriers through instruments such as the CTBLQ may provide nursing educators with valuable diagnostic information to design targeted educational strategies that strengthen collaborative competence, support clinical reasoning development, and facilitate the preparation of graduates capable of contributing to safe and effective patient care.

4.5. Paradigm Shift in Nursing Assessment: Diagnostic Novelty of the CTBLQ

The psychometric validation of the CTBLQ represents an important advancement in nursing assessment by introducing a dedicated instrument for identifying barriers within active learning environments. By identifying specific challenges across an 18-indicator framework, the CTBLQ addresses an important measurement gap in health professions education by focusing on barrier-related experiences that may influence collaborative learning processes. Existing assessment approaches in Team-Based Learning have primarily emphasized positive learning outcomes, student satisfaction, and engagement, whereas fewer instruments have been designed specifically to examine challenges that may interfere with effective team functioning during collaborative learning. The empirical foundation established in this study provides a structured framework for identifying functional constraints, thereby extending assessment approaches beyond generalized evaluations toward more targeted diagnostics of team learning barriers.

To fully appreciate the diagnostic contribution of the CTBLQ, its conceptual orientation should be considered alongside established Team-Based Learning assessment instruments. The Team-Based Learning Student Assessment Instrument (TBL-SAI) developed by Mennenga (2012) represents an important contribution by evaluating students' accountability, preference for Team-Based Learning, and satisfaction with the learning experience. Recent studies have further highlighted the positive educational outcomes, student engagement, teamwork development, and learning experiences associated with Team-Based Learning implementation (Alberti et al., 2021; Considine et al., 2021; Yeung et al., 2023).

However, these existing assessment approaches were not primarily designed to diagnose barrier-related experiences, interpersonal difficulties, and contextual challenges that may influence effective team functioning. The CTBLQ was therefore developed to complement existing measures by providing a structured diagnostic framework for identifying challenges that influence active learning implementation.

The structural capacity of the CTBLQ aligns with contemporary efforts to strengthen quality assurance and evidence-informed decision-making within health professions education. As nursing and health education systems continue to implement competency-based curriculum reforms, reliable assessment frameworks are increasingly important for identifying educational challenges and informing continuous improvement processes (Horii et al., 2021; Mikkonen et al., 2022). The CTBLQ may serve as a practical diagnostic instrument for periodic curriculum evaluation by enabling educators and academic administrators to identify operational barriers associated with Team-Based Learning implementation. By providing empirical evidence rather than relying solely on informal feedback, the instrument may support targeted faculty development initiatives, refinement of instructional strategies, and more contextually appropriate educational planning. Ultimately, integrating systematic assessment of learning barriers into nursing education quality improvement processes may contribute to the development of more effective collaborative learning environments and better preparation of future healthcare professionals.

5. CONCLUSION

This methodological study successfully developed and psychometrically validated the Challenges in Team-Based Learning Questionnaire (CTBLQ) for use among undergraduate nursing students in Vietnam. The final instrument comprises 18 measurable indicators and demonstrated excellent internal consistency together with satisfactory construct validity. Exploratory factor analysis supported a three-factor structure representing learning preparation, participation, and motivation challenges; interpersonal and social conflict challenges; and learning benefit and team harmony challenges. Collectively, these findings indicate that the CTBLQ provides a psychometrically sound instrument for identifying barriers encountered during Team-Based Learning implementation. By addressing an important measurement gap in nursing education, the instrument complements existing Team-Based Learning assessment tools that primarily evaluate positive educational outcomes, student satisfaction, and learning preferences.

The findings have important implications for nursing education and curriculum evaluation. As a standardized diagnostic instrument, the CTBLQ may assist nurse educators in identifying whether students' learning challenges are primarily associated with preparation for learning, classroom participation, interpersonal and social interactions, or perceived learning benefits during Team-Based Learning activities. Such information may support evidence-informed decisions regarding instructional design, faculty development, team formation strategies, and student learning support. Furthermore, within nursing education systems that are transitioning toward competency-based and learner-centred curricula, the CTBLQ may provide an objective framework for monitoring active learning implementation and informing continuous quality improvement initiatives.

Several limitations should be considered when interpreting the findings of this study. First, the instrument was validated using data collected from undergraduate nursing students at a single university in Vietnam, which may limit the generalizability of the findings to other institutional or cultural contexts. Second, although exploratory factor analysis established the underlying factor structure of the CTBLQ, confirmatory factor analysis was not performed to verify the stability of the three-factor model. Future research should therefore validate the instrument across multiple universities and diverse educational settings, conduct independent confirmatory factor analysis, and further examine additional psychometric properties, including test-retest reliability, convergent validity, criterion validity, and measurement invariance. Evaluating the relationships between CTBLQ scores and educational outcomes such as student engagement, teamwork performance, collaborative competence, and academic achievement would also provide further evidence supporting the instrument's broader applicability. Overall, the CTBLQ offers a psychometrically supported framework for identifying barriers to Team-Based Learning and provides a valuable foundation for future research and evidence-informed improvement of collaborative learning in nursing and health professions education.

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