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Design and Validation of the Flipped-Learning Assessment Scale for Undergraduate Nursing Education

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ABSTRACT

Aim: To design and validate the Flipped-Learning Assessment Scale; a tool for assessing students' experience of flipped learning.

Background: Frequently, university students are introduced to new content during lectures. In contrast, active learning activities, such as Flipped Learning, are designed as an instructional method to engages students in the learning process.

Design: Cross-sectional descriptive study.

Methods: A cross-sectional study was carried out in three phases ((1) item selection, rephrasing and translation; (2) content analysis through expert panel and (3) confirmatory factor analysis). The final version of the scale was piloted on a sufficient sample of undergraduate student nurses from three Spanish universities.

Results: A total of 455 students completed the questionnaire; 373 women and 82 men. The total Cronbach's alpha value for the complete instrument was 0.893. Cronbach alpha for each separate dimension ranged between 0.660 and 0.897. Goodness-of-fit values were acceptable, implying that the model was validated.

Conclusion: The flipped learning approach has become increasingly popular in academic settings. Evaluating the students' flipped learning experience is important to analyse aspects such as acceptability and effectiveness of this methodology. The Flipped-Learning Assessment Scale is a valid and reliable tool for analysing students' experience of flipped learning.

Impact: Flipped learning has been a useful pedagogical model very for cultivating student skills in problem-solving, critical thinking, teamwork and self-active learning in nursing education. A key issues, such as student satisfaction, has been explored further before implementing this teaching and learning methodology.

Patient or Public Contribution: None.

1 | Introduction

Lecture-based instruction continues to be predominant in higher education (Zhao, He, and Su 2021). Frequently, university students are introduced to new content during lectures. Subsequently, students may be set an assignment that is based on knowledge acquired in the classroom, and requires them to use higher-order thinking skills, such as applying,

synthesising, evaluating or creating (Prince 2004). If, in the process of completing the assignment, a student experienced any difficulties, then he or she would need to ask a peer or a teacher for help. However, feedback may not be timely in this case, which may affect student performance.

Over the past few decades, the outcomes of undergraduate nursing studies have evolved. For instance, nursing students today find it relatively easy to autonomously access digital information. This suggests that the time spent in the classroom might be better redirected towards student-centred and collaborative learning (Mellati, Khademi, and Shirzadeh 2015; Munir et al. 2018). As a result, educators face the challenge of gradually shifting from being providers of evidence to becoming architects of learning activities (Sarkio, Korhonen, and Hakkarainen 2023). Active learning methods, such as Flipped learning (FL), are designed as complementary and instructional approaches that engage students in the learning process and contribute to the evolution of pedagogical practices based on horizontal relations and knowledge exchange (Salmon, Tombs, and Surman 2019). In the context of nursing education and training, FL, as a pedagogical model, transforms traditional, teacher-centred, lecture-based education into student-centred and active, collaborative learning.

In the specific context of undergraduate nursing studies, incorporating the FL pedagogy could lead to positive educational outcomes (Youhasan et al. 2021), and help students acquire key nursing-specific professional competencies. This includes developing teamwork skills and utilising multiple intelligences to solve problems (Adams and Dove 2018; Morrell and Ball 2020). It involves students participating in teaching and learning activities before the actual lesson, such that homework assignments are completed during scheduled classrooms sessions (Sargent and Casey 2019). In this scenario, when a student attends a session and engages in a FL activity that requires higher-order thinking skills, peers can provide instant assistance if any difficulties arise. Additionally, this strategy provides immediate feedback (Márquez-Hernández et al. 2019; Morrell and Eukel 2020) as the instructor acts as a facilitator (Binoy 2024), promoting the application of theoretical content to practice through collaborative and experiential learning.

This model could transform nursing education by shifting traditional dynamics and increasing interaction between the instructor and students, who become active learners instead of being passive receptacles of information. In other words, in FL, the responsibility and ownership of learning are transferred from the lecturer to the students through participation in interactive activities (Cai et al. 2022). Recent studies and literature reviews on FL have discussed the advantages of this educational approach (Adams and Dove 2018; Biju et al. 2020; Cao and Swada 2020; Halasa et al. 2020; Pozo Sánchez et al. 2019; Sargent and Casey 2019; Wang and Zhu 2019), such as enhancing the students' academic performance, autonomous learning ability and classroom satisfaction (Hu and Zhao 2022; Su et al. 2023). This approach has shown its potential not only with theoretical contents, but also in clinical practice, as it helps improve communication skills (Lee and Jang 2021) and strengthens nursing competence in response to changes in the clinical environment (Park and Suh 2021).

1.1 | Background

After a literature search on PubMed, EMBASE, CINAHL, PsychINFO and CUIDEN, we were able to find studies that partially resembled the tool we theoretically understood to be necessary for evaluating flipped learning environments. On one hand, the work of (Barua et al. 2014), who developed a 10-question feedback questionnaire to assess students' experience with flipped teaching. On the other hand, (Choi et al. 2021) evaluated their flipped teaching using a mixed-methods approach, employing among other tools, six contrasting questions to compare flipped teaching with traditional teaching. Although neither of these studies conducted a tool validation analysis, they provided a foundational basis for the development of this research. As it is crucial to evaluate both the efficiency and student satisfaction of each teaching-learning activity before permanently integrating them into the teachers' repertoire (Urcola-Pardo et al. 2018), continued research in these areas will contribute to a deeper understanding of the impact of FL and other strategies, helping educators make informed decisions about its integration into nursing education.

2 | The Study

2.1 | Aim

The aim of this study was to design and validate the 'Flipped-Learning Assessment Scale (FLAS)' to assess the nursing student FL experience.

2.2 | Desing

A cross-sectional study was carried out in three phases. Phase 1: item selection, rephrasing and translation; Phase 2: content analysis through expert panel and Phase 3: construct analysis through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

2.3 | Participants, Setting and Sample

Content analysis was performed using the expert panel technique. An expert panel comprising 11 lecturers from four public universities took part in this second phase. As the final instrument has 14 items, a minimum sample of 340 students was required. The participants for this third phase were nursing undergraduate students from three different Spanish universities. The sample size calculation for the EFA was based on the 5–10 subjects per item rule (Morgado et al. 2018), while for CFA a sample of at least 200 subjects was estimated (Myers, Ahn, and Jin 2011). The final version of the FLAS was piloted on a sample of 455 first, second and third-year undergraduate student nurses from three universities. To be included in the study, the participants were required to be enrolled in one of the courses that incorporate FL methodology, to have participated in at least one FL session, and to have completed the questionnaire. Individuals whose questionnaires were incomplete were excluded from the study.

2.4 | Data Collection

2.4.1 | Phase 1: Item Selection, Rephrasing and Translation

The development of the FLAS was initially performed by a group of five experts in nursing education with prior experience in flipped learning. This group selected the items from the feedback questionnaire used by Barua et al. (2014) and the flipped classroom evaluation performed by Choi et al. (2021). Items 4 and 7 from Barua et al.'s study were excluded from the FLAS. Item 4, 'The classroom arrangements (positioning of chairs for group activity, audio-visual facilities, etc.) were conducive for the FC activity', was excluded as classroom infrastructure in Spain does not always allow for the adjustments suggested; item 7, 'More lectures should be conducted in the FC mode', was excluded as it was not clear whether the item refers to a specific module or the degree program as a whole. All the items from Choi et al.'s questionnaire were included. However, they were rewritten in order be measured on a 5-point Likert scale with the aim of homogenising the style of the items. All these items were phrased positively with the exception of item 10, which was phrased negatively as a control item. Also, FL and FC are terms that are often used interchangeably, but they can have slightly different meanings depending on the context, that is, while FC is a specific application of FL, where the inversion is applied at the level of individual lessons or class session, FL is a broader concept that encompasses any inversion of the traditional learning model. For this reason, we decided to use FL instead of FC in the FLAS items.

The proposed version of the FLAS tool (Table 1) was designed to be answered on a 5-point Likert scale ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree), using item 10 as reversed score. The theoretical structure of the design anticipated the appearance of three dimensions: (1) materials and session activities (items 1 to 5); (2) lecturer's work (items 6 to 8) and (3) comparison with traditional classes (items 9 to 14). The score for each dimension at this point was proposed as its average score.

Once the construction of the scale was completed, the proposed items were translated were translated into Spanish by two English-speaking translators. Next, both translations were unified into a first Spanish version. This Spanish version was translated back into English by two different English-speaking translators following the same method (retro-translation). After confirmation by the four translators that the two English versions were equivalent, the study stepped into the next phase.

TABLE 1 | Proposed items for the FLAS.

I.1	Pre-reading materials (i-Lecture/others) were available on eLearning portal before the FL activity
I.2	Adequate time was provided to spend on the pre-reading materials (i-Lecture/additional references etc.) before the FL activity
I.3	Pre-reading materials and i-lectures were relevant for the FL activity
I.4	The activities during FL session improved my understanding of the key concepts
I.5	The FL session inspired me to pursue further learning for the module
I.6	Instructor was able to engage me in the FL activity
I.7	Instructor was able to provide clarification on difficult concepts during the FL activity
I.8	Instructor was able to expand on i-lectures and pre-reading materials during the FL activity
I.9	Comparing with traditional class, FL is more effective to achieve learning outcomes
I.10	Comparing with traditional class, FL is harder to concentrate
I.11	Comparing with traditional class, FL is more efficient
I.12	Comparing with traditional class, FL is more interesting
I.13	Comparing with traditional class, FL is easier to understand
I.14	Comparing with traditional class, FL is more familiar and comfortable

2.4.2 | Phase 2: Content Analysis Through Expert Group

Content validation was performed to assess the level of representativeness, relevance, understandability and completeness of FLAS. A group of 11 experts (8 experts in Nursing Education and 3 experts in Psychology and Pedagogic Sciences) reviewed the Spanish version of the questionnaire. The experts received the first version of the tool by email and were asked to assess each item's relevance and validity, and also the tool as a whole, using the following guidelines: (1) for each item they answered the following questions: (a) Do you consider that the statement is relevant for evaluating a flipped classroom environment?; (b) As it is currently worded, do you think students will adequately understand the item? and (c) Would you make any changes (add or remove information) to this item? If so, make your alternative proposal. (2) For the whole scale, they answered the next questions: (a) Do you believe the overall tool will provide sufficient information to evaluate your students' experience in a flipped classroom environment?; (b) Would you add any items to those proposed? and (c) Would you remove any of the proposed items? If so, which one and why? As the experts did not propose any changes to this version of the questionnaire, the researchers concluded that the questionnaire was well-designed, valid and reliable for gathering the intended information.

2.4.3 | Phase 3: Psychometric Analysis Performing EFA and CFA

This last phase consisted in collecting the students' responses after receiving the last flipped-classroom session of the subject and performing the statistical analysis.

2.5 | Data Analysis

The data were analysed using IBM SPSS v22 for descriptive analysis, reliability analysis and EFA, while IBM AMOS v22 was used for the CFA. The results for the quantitative variables were presented as mean and standard deviation (SD) while the absolute and relative frequencies (n and %) were used for the qualitative variables. In order to perform the EFA and CFA, we used the half-split method of the sample with SPSS, obtaining a first sample of $n = 232$ and a second sample of $n = 223$. With the first sample, an EFA was performed estimating the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests, extracting the loading factors (>1) using Varimax rotation. To confirm the structure, a CFA was applied to the second sample, assessing the model fit by using recommended fit indices from Hu and Bentler (1999) and Yu (2002), estimating chi-squared and degrees of freedom ratio (χ^2/df), Normed Fit Index (NFI), Comparative Fit Index (CFI), incremental fit index (IFI), Tucker-Lewis Index (TLI) and root mean square of approximation (RMSEA). According to the interpretation suggested by Marsh, Hau, and Wen (2004) and Little (2013), CFI and TLI values above 0.90 and RMSEA below 0.08 reflect an adequate fit. Finally, a descriptive analysis of the items, dimensions and the entire instrument was performed, while Cronbach's alpha was estimated for each dimension obtained and the entire instrument.

2.6 | Ethical Consideration

This educational research project was carried out according to the Declaration of Helsinki (World Medical Association, 2013) and was approved by the Vice-rectorate for Innovation from the University of Huelva as part of the tenth call for teaching innovation projects. The background, aim and importance of the students' participation were explained to them before the completion of the questionnaire. Furthermore, the online questionnaire included a brief explanation of the main aim of the study and also an explicit mention of their agreement to participate with the answer. The confidentiality of the data and the anonymity of the response were guaranteed at all times.

3 | Results

A total of 458 students completed the questionnaire. However, three responses were withdrawn due to being incomplete. The final sample comprised 455 nursing students, 373 of whom were women (82%) and 82 were men (18%). Mean age was 21.62 years (SD: 5,43). 260 (57,1%) students were registered at the University of Huelva, 164 (36,1%) were from the University of Zaragoza and 31 (6,8%) were from the University of Sevilla. 60,8% of the participants were third year nursing students, 5,1% were second year students and 34,1% were in their first year of the Bachelor of Nursing degree (Table 2).

TABLE 2 | Descriptive analysis of the student sample.

Variable	Category	*N*	%
Sex	Woman	373	82
	Man	82	18
University	Huelva	260	57.1
	Sevilla	31	6.8
	Zaragoza	164	36.1
Year	First	155	34.1
	Second	23	5.1
	Third	277	60.8

TABLE 3 | EFA rotated component matrix and % of explained variance.

	Component		
	1	2	3
Item 1		0.653	
Item 2		0.765	
Item 3		0.731	
Item 4		0.626	
Item 5		0.737	
Item 6			0.542
Item 7			0.667
Item 8			0.776
Item 9	0.864		
Item 10[a]	0.608		
Item 11	0.881		
Item 12	0.852		
Item 13	0.872		
Item 14	0.783		
% variance	36,523	16,485	12,993

[a]Reversed score item.

3.1 | Exploratory Factor Analysis

EFA was performed with the first half of the sample ($n = 232$) in order to determine the structure of the instrument, obtaining a Kaiser-Meyer-Olkin (KMO) = 0.912 and a significant Bartlett's test ($X^2(91) = 1817.62$, $p < 0.001$). Applying a Varimax rotation with Kaiser normalisation, a three factors structure was obtained (Table 3), explaining 66% of the variance.

3.2 | Confirmatory Factor Analysis

CFA was conducted with the second half of the sample ($n = 223$) to examine the factorial structure of the proposed model. The chi-square test reported a value of 176,901 with 74° of freedom (χ^2/df = 2391). The normed fit index (NFI) obtained a value of 0,900, indicating a good fit between the model and the data. Similarly, the incremental fit index (IFI) and the Tucker-Lewis index (TLI) yielded values > 0,9 indicating a satisfactory fit. The

comparative fit index (CFI) also obtained a value of 0,938, further supporting the adequacy of the proposed model. Additionally, the root mean square error of approximation (RMSEA) yielded a value lower to 0,08, suggesting a reasonably good fit between the model and the observed data (Table 4). The CFA confirmed the theoretical structure of three dimensions (Figure 1): (1) materials and session activities (items 1 to 5); (2) lecturer's work (items 6 to 8) and (3) comparison with traditional classes (items 9 to 14).

3.3 | Reliability Analysis and Descriptive Analysis of the Scale

For the reliability and the descriptive analysis of the scale, the whole sample data was used. Cronbach's alpha value for the whole instrument was 0.893. The reliability of each item was tested using the alpha value if the item was deleted. We found that deleting items 2, 8 (alpha value if item deleted 0.895) and 10 (alpha value if item deleted 0.901) increased reliability. Alpha values for the first dimension (materials and session activities) were 0.740 with no benefit from eliminating any of the items; 0.660 for the second dimension (lecturer's work) with benefit from eliminating item 8 ($\alpha = 0.741$) and 0.897 for the third dimension (comparison with traditional classes) with benefit from eliminating item 10 ($\alpha = 0.934$).

The descriptive analysis of the 14 items (Table 5) was conducted using mean and standard deviation. The first item obtained the highest value, with a mean of 4,76 (SD = 0,64), while the lowest value was obtained by item 9, with a mean of 3.68 (SD = 1,27). The dimensional analysis revealed the highest value for the second dimension (lecturer's work), with a mean of 4,50 (SD = 0.63) and the lowest value for the third dimension (comparison with traditional classes) with a mean of 3,76 (SD = 0,98).

4 | Discussion

FL is recognised as a valuable factor for determining pedagogical effectiveness. The present study describes the development and validation of the FLAS tool to measure nursing students' experience of FL. More specifically, the study explored the construct validity and reliability of the FLAS scale.

Specifically, the integration of theoretical knowledge with clinical experience has been a fundamental aspect of learning in nursing undergraduate studies (Lee and Jang 2021; Park and Suh 2021; Su et al. 2023). This bridge between theory and practice is crucial for developing well-rounded healthcare professionals who possess a diverse set of skills and competencies. However, some authors have argued that the implementation of FL raises important questions regarding its effectiveness in improving students' outcomes and satisfaction in higher education environments (Brewer and Movahedazarhouligh 2018; Karabulut-Ilgu, Jaramillo Cherrez, and Jahren 2018; Shibukawa and Taguchi 2019). Critics argue that while FL promotes active learning and engagement, its success heavily depends on several factors such as the quality of pre-class materials, the readiness of students to adapt to this new learning style, and the ability of instructors to effectively facilitate in-class activities (Brewer and Movahedazarhouligh 2018; Karabulut-Ilgu, Jaramillo Cherrez, and Jahren 2018; Ni et al. 2024). Moreover, the transition from traditional teaching methods to FL can be challenging for both educators and students, requiring substantial shifts in mindset and teaching practices.

The method used to construct the FLAS was similar to the procedure used for the development of FL scales in other disciplines, and included proposing constructs, item generation, analysis of the content, item reduction and validation of the newly developed instrument (Lee et al. 2022). The three factors derived from the EFA were subsequently confirmed through CFA. Thus, it can be affirmed that, despite having eliminated two of the items originally used by Barua et al. (2014), their proposal would have benefited from conducting a factor analysis. In our case, using 8 of their 10 items resulted in a two-factor structure, with the third factor comprising the six items derived from the statements of Choi et al. (2021). Although the current trend in interpretation is not to dismiss a model that does not meet the fixed values traditionally considered appropriate in CFA (McNeish and Wolf 2023), our model presents acceptable values of goodness-of-fit indexes, as the NFI, IFI, TLI and CFI were $\geq$0,9, while the RMSEA were under 0,08 (Hu and Bentler 1999; Marsh, Hau, and Wen 2004).

In the reliability assessment, the FLAS demonstrated acceptable internal consistency. All three factors of the FLAS generated Cronbach alpha greater than 0.7, confirming internal consistency within the domains and the ability of the FLAS to generate reproducible results according to (Taber 2018). Yet, the FLAS Cronbach Alpha is slightly lower (0,893 vs. 0,912) than the value obtained by Barua et al. (2014). However, compared with their analysis, our approach determined that their analysis could benefit of a factor analysis, as despite of excluding two of their items, our results suggest that these questions measure at least two different dimensions. Moreover, the shorter and simpler questions in the FLAS can be more easily answered. This comparison could not be performed with Choi et al. results, as their work did not include a reliability assessment. Our findings on the scale's reliability are supported by the proposals of Tavakol and Dennick (2011), as alpha values increase as items are added. This supports the fact that the FLAS shortest dimension (three items) is the one with the lowest Cronbach alpha.

Finally, our students' answers were similar to each item to the individual values reported by Barua et al. (2014) and Choi et al. (2021), and also, we compared our dimension 'comparison with traditional classes' with the mean reported by Choi et al. (2021), obtaining our sample a slightly higher mean.

TABLE 4 | CFA values for the Flipped-Learning Assessment Scale theoretical model.

χ^2	gl	χ^2/gL	NFI	IFI	TLI	CFI	RMSEA
283.009	74	3824	0.919	0.939	0.924	0.939	0.079

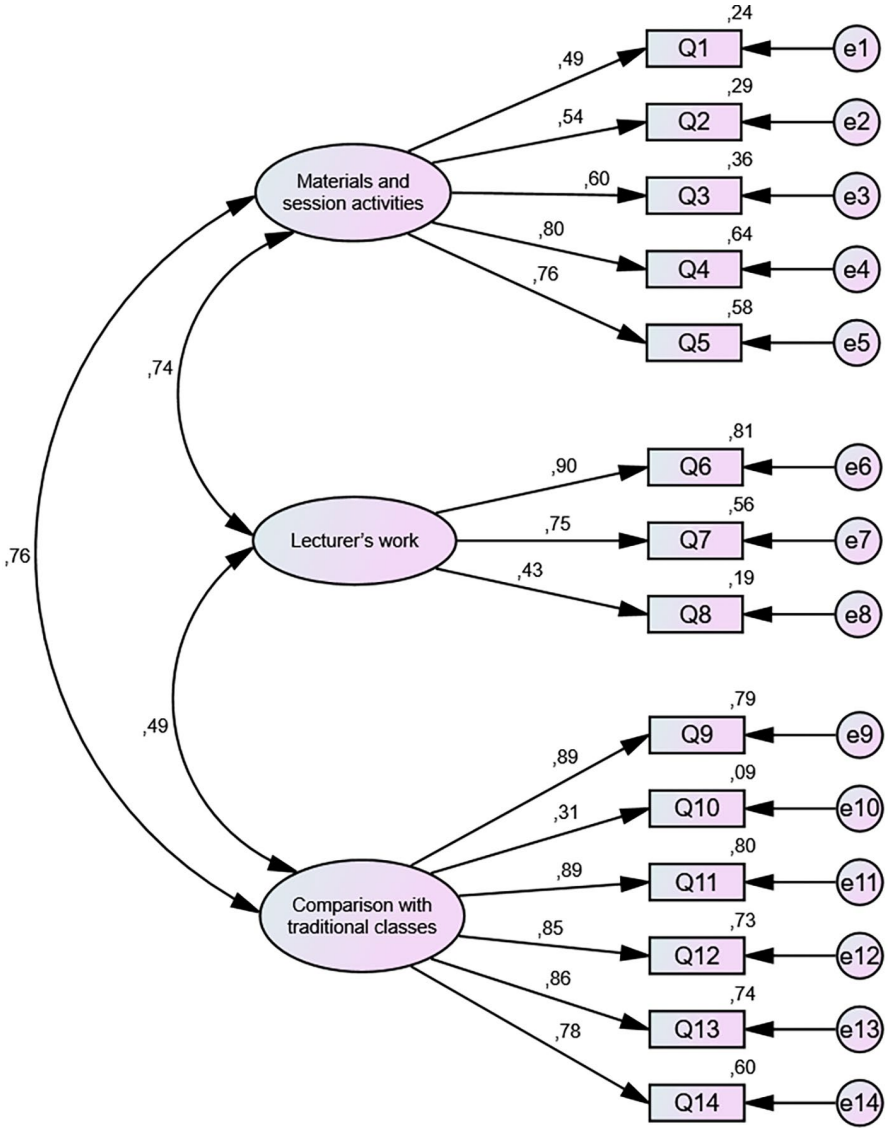

FIGURE 1 | FLAS model diagram.

Beyond the statistical analysis, the three factors derived from the factor analysis represent key factors for analysing the experience of flipped learning environments among university students. The first factor, 'Materials and session activities,' is crucial in flipped learning environments. Providing engaging and interactive learning materials outside of class allows students to learn at their own pace and prepares them for in-depth activities during class sessions (McLaughlin et al. 2013). The flipped classroom model emphasises pre-class learning materials, such as video lectures, to introduce concepts, while in-class time focuses on active learning through problem-solving and group work (Long et al. 2016). This student-centred approach promotes active learning pedagogy (Fuchs 2021).

The second factor, 'lecturer's role,' is significant in shaping students' experiences in flipped classrooms. Educators must understand how to redesign traditional curricula into flipped learning classes by considering course objectives and learner needs (Kim and Jeong 2016). Lecturers who embrace technological challenges, cater to diverse student cohorts and reflect on their teaching practices contribute to a positive learning experience in flipped classrooms (Panicker and Sheedy 2018). Additionally, guidance provided by lecturers in digital environments is crucial for students' success in flipped learning settings (Sawirman 2021).

Finally, the third factor, 'Comparisons with traditional classes,' is essential for evaluating the impact of flipped learning on student experiences. Flipped classrooms depart from traditional lecture-based approaches by emphasising student-centred learning and interactive activities that enhance problem-solving skills and self-leadership (Hwang and Oh 2021). Research indicates that flipped classroom models lead to improved student performance and satisfaction compared to traditional lecture-only approaches (Missildine et al. 2013; Parut and Buntari Agustini 2019). Moreover, the flipped classroom allows more in-class time for students to practice and apply knowledge, fostering awareness-centred learning and innovation (Sawirman 2021).

TABLE 5 | Descriptive analysis of each item and dimension.

	Mean	SD
Item 1	4.76	0.64
Item 2	3.89	1.21
Item 3	4.57	0.73
Item 4	4.18	0.93
Item 5	3.72	1.13
Item 6	4.50	0.81
Item 7	4.75	0.61
Item 8	4.25	0.99
Item 9	3.68	1.27
Item 10[a]	3.41	1.37
Item 11	3.74	1.15
Item 12	3.86	1.18
Item 13	3.79	1.18
Item 14	4.10	1.07
Dimension 1	4.22	0.67
Dimension 2	4.50	0.63
Dimension 3	3.76	0.98

[a]Reversed score item.

4.1 | Limitations

There are several limitations of our study. First, there is a need for a discussion on the resources used and the benefits of the methods. Huge expectations seem to be related to educational activities in higher education and to swapping auditorium lectures to smaller seminar groups and individuals using active learning activities. This study raises questions about this trend. Intervention studies in higher education might be challenging when students can choose to attend to the class or find other learning solutions. Also, although we recruit participants from three universities in Spain, our study sample could not be sufficiently representative via convenience sampling. Therefore, a larger sample is recommended to confirm the stability and usefulness of the FLAS.

5 | Conclusion

Despite the limitations, our results show that the FLAS is a valid and reliable tool to analyse nursing students' experience of Flipped Learning activities. As the FL approach is incorporated into the academic setting in order to promote active, student-centred learning, evaluating these learning experiences becomes more necessary to properly assess the effectiveness of different educational approaches.

Author Contributions

Fernando Urcola-Pardo: conceptualization, methodology, investigation, formal analysis, writing original and editing; Ana Belen Subiron-Valera: investigation, formal analysis, resources, writing original and editing; Isabel Anton-Solanas: formal analysis, writing review and editing; Aintzane Orkaizagirre-Gomara: formal analysis, writing review and editing; Dolores Torres-Enamorado: formal analysis, writing review and editing; Juan Diego Gonzalez-Sanz: conceptualization, methodology, investigation, formal analysis, writing original, editing and supervision.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.