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Student-led video project to develop teamwork, communication and digital skills in first-year nursing students: a longitudinal quasi-experimental study

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Abstract

Background Soft skills—such as teamwork, communication, and digital competence—are essential in nursing education to ensure safe, patient-centered care. However, they are not always systematically developed or assessed in undergraduate programmes.

Methods The aim of this study was to evaluate the long-term impact of a collaborative, student-led video simulation project on the development of teamwork, communication, and digital competencies among first-year nursing students, and to explore gender-related differences. A longitudinal quantitative study was conducted in which students worked in self-selected groups to design and produce a short instructional video simulating a nursing technique. The intervention was embedded in practical sessions and included a workshop on video tools and peer- and instructor-led presentations. Teamwork was assessed using the validated RUTE questionnaire through self- and peer-assessment, while digital and communication skills were measured using an ad-hoc questionnaire. Outcomes were measured at baseline (T1), post-intervention (T2), and one-year follow-up (T3).

Results Of the 167 eligible students, 164 participated (98.2%). Teamwork self-assessment improved significantly in Active Participation (dim 3: T1–T2 $p=0.01$; T1–T3 $p=0.006$) and Achievement of Agreements (dim 7: T1–T2 $p=0.001$; T1–T3 $p=0.01$). Coordination (dim 5) improved from T1 to T3 only ($p=0.02$). At T2, peers rated classmates higher than self-ratings in most dimensions, indicating self-underestimation. Digital skills ($n=134$ T1; $n=100$ T2; $n=53$ T3) increased in five of six items short-term; by T3, information sharing, content creation and use of multiple file types showed sustained gains. Communication improved short-term in non-verbal aspects and topic-appropriate speaking, with partial retention at T3. Gender analyses indicated baseline differences in task fulfilment and longer-term gains in certain digital skills among men; interpretation is cautious due to female predominance.

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Conclusions A low-complexity, student-led video project integrated into practical teaching produced immediate and sustained improvements in key soft skills, especially active participation, consensus-building, non-verbal communication and digital creation. Some competencies (e.g., coordination, digital sharing) developed gradually, underscoring the value of repeated exposure across the curriculum. Inclusive group design and reflective practices may help address observed gender-related patterns.

Keywords Teamwork, Communication skills, Digital competence, Nursing education, Peer assessment, Simulation training

Background

In recent years, the international nursing education community—including Europe, the United States and Australia—has prioritized the development of competency-based curricula to better prepare future professionals for the demands of complex, digitalized, and team-centered healthcare environments [1–3]. Within these frameworks, soft skills such as communication, teamwork, and digital competencies have been recognized as critical elements for delivering safe, patient-centered care and for ensuring the professional effectiveness and well-being of healthcare workers [4–7].

Soft skills are particularly relevant in high-stakes environments like hospitals, where failures in communication or teamwork are major contributors to adverse events [8]. Developing these abilities involves mastering sub-skills such as negotiation, conflict resolution, shared decision-making, and digital fluency [9]. As a result, many nursing schools have begun exploring innovative pedagogical strategies to embed these competencies early in the undergraduate curriculum [10].

However, significant gaps remain. Despite growing attention to the digital transformation of healthcare, there is a lack of structured and evaluated programmes aimed at fostering digital competencies in nursing education [11].

To ensure that students can effectively use digital health technologies in patient care, recent research emphasizes the necessity of incorporating practical experiences with these tools into clinical training [12]. Despite the fact that many students are familiar with the fundamentals of digital tools, they frequently feel unprepared to use them in clinical settings [13], highlighting a persistent disconnect between theoretical knowledge and practical application.

Similarly, although communication and teamwork are broadly accepted as essential for interprofessional collaboration and patient outcomes, they are not always systematically taught or assessed [5]. Research shows that early training in teamwork improves students' readiness for clinical practice [14], while also fostering motivation and job satisfaction. Nevertheless, assessment methods often rely on self-perceptions, which may not fully capture actual competence levels [15]. Peer assessment has been proposed as a complementary strategy, offering more comprehensive insights into students' collaborative behaviour and increasing their engagement and accountability [16].

In addition, gender differences in communication styles, digital confidence, and collaborative behaviours have been documented [17, 18] suggesting the importance of incorporating a gender-sensitive perspective when designing and evaluating educational interventions aimed at soft skills development.

Among soft skills, evaluating teamwork competencies is a cornerstone. There are several tools available in the context of nursing and health education, such as the LTSES Leadership/Teamwork Self-Efficacy Scale [19], the GSE-Generalized Self-Efficacy Scale [20] and the TeamSTEPPS questionnaire [21]. Many, though, concentrate on different aspects of teamwork skills or are context-specific, such as emergency response to mass casualty simulations, managing patients or working in critical care teams, or measuring interpersonal competence beliefs in STEM (science, technology, engineering, and mathematics) academic settings or research projects.

The RUTE scale [22], which evaluates a variety of teamwork-related behaviours through peer and self-assessment, is distinctive and offers valuable insights into the dynamics of student teams.

The two most suggested approaches for developing soft skills are group video production and simulation-based learning. The latter encourages students to collaborate, communicate clearly, and use digital tools, particularly when used to simulate clinical procedures. Even though educational video projects can improve learning and unity, they can also present difficulties, especially for students who are not used to working in groups or who are under time pressure [23]. Managing these challenges well can improve teamwork, communication, and creativity skills while encouraging increased use of digital technologies.

Given the relevance of these competencies for nursing practice, it is essential not only to promote their development through active learning strategies, but also to assess them using appropriate and validated instruments that capture multiple dimensions of teamwork, communication, and digital competence.

Therefore, the aim of this study was to evaluate the long-term effectiveness of a student-led video-based intervention focused on nursing procedures in fostering

key soft skills—specifically communication, teamwork, and digital competencies—among first-year nursing students, and to explore potential gender-related differences in the development of these competencies over time, in alignment with international nursing education standards, including the WHO Global Standards for Nursing and Midwifery Education [24], and with the intention of providing a replicable educational model.

Methods

Design

This study adopted a quasi-experimental longitudinal quantitative design to evaluate changes in teamwork, digital, and communication competencies among first-year nursing students across multiple time points.

As part of the project, students worked in small groups to produce brief instructional videos that showed them how to correctly perform a technique that was covered in the course's practical sessions. Examples of these techniques included spirometry, blood pressure measurement, and electrocardiogram recording.

The study was carried out at the Faculty of Health Sciences (University of Zaragoza), as part of the Physiology course for the Nursing Degree programme.

In order to encourage digital and collaborative learning approaches in undergraduate nursing education, the project was a component of an institutional teaching innovation initiative.

Due to practical limitations and ethical considerations, a control group was excluded in order to guarantee that every student had equal access to education. Considering that the intervention's goal was to improve teamwork and was incorporated into a required practical component. Furthermore, as the objective was to foster the acquisition of soft skills competencies through a structured pedagogical process rather than to test an isolated perception change, the inclusion of a control group was not consistent with the educational purpose of the study.

Reporting follows the TREND statement for nonrandomized evaluations and the TIDieR checklist for intervention description.

Participants

All first-year nursing students enrolled for the first time in the Physiology course were invited to participate ($N = 167$; mean age = 20.5 ± 6.35 years). Students repeating the course were excluded because they were not required to complete the practical component. Three students declined participation; the final sample comprised 164 first-year students (98.2%).

The sample consisted predominantly of female students, reflecting the gender distribution of the nursing degree programme. Of the 164 participants, approximately 79% were women.

As first-year students, participants had no prior clinical placement experience at the time of the intervention, and no structured or formal instruction in teamwork, digital content creation, or oral presentation skills had been included in the nursing curriculum prior to the intervention.

Intervention

The intervention was embedded within the regular practical sessions of the Physiology course, which comprised seven two-hour classes covering topics such as metabolism, blood analysis, cardiovascular and respiratory assessment, and nervous system exploration. Sixteen groups of approximately 10–12 students were organized following the standard course schedule.

During these sessions, the instructor introduced and demonstrated each physiological technique, ensuring that students gained the necessary technical understanding before applying it in the video project. Approximately 30 min at the end of each class were reserved for students to ask questions, receive feedback, coordinate their group work, and complete the questionnaires related to the activity. The remaining time focused on the hands-on practice of physiological techniques. This structure allowed students to consolidate technical knowledge during class and later apply it creatively through their collaborative video projects.

The video project was included as part of the course's practical assessment. Although participation was voluntary, students were informed that the activity contributed to their overall practical grade; non-participation did not imply failure but could result in a lower score.

Teams of five to seven students designed and produced a short (≤ 5 min) instructional video simulating a nursing technique related to the course's physiological content. Work was carried out autonomously and collaboratively following a predefined schedule with clear deadlines for group formation, technique selection, video submission, and presentation. All instructions were provided at the beginning of the semester to ensure transparency and consistency throughout the process.

Groups were self-organized, allowing students to freely choose their teammates and the technique to be demonstrated. While each practical group included around twelve students, video teams could include members from different sessions, encouraging collaboration based on affinity and shared interests. A public list of selected techniques was posted on the virtual learning platform, enabling students to view others' choices and select less-represented topics if desired. This open approach promoted diversity and autonomy while maintaining accountability.

An outside specialist in audiovisual production delivered an additional one-hour session on digital tools for

video recording and editing. Free and open-source software, together with applications covered by the university's institutional licenses (such as Microsoft 365 and Canva Education), were used for all video production, ensuring equal access to digital resources regardless of students' prior experience or equipment. Through a dedicated booking system, students could also reserve university spaces and borrow materials such as stethoscopes, spirometers, and ECG devices.

Three final sessions (approximately two hours each) were dedicated to video presentations at the end of the semester. During these classes, the videos were screened and evaluated in real time by peers and the instructor using a shared rubric. All guidance and supervision were provided by the same faculty member, who was responsible for the course's practical sessions.

Instruments

All instruments were administered as self-report measures using standardized Likert-type response formats and were selected to align with the competencies targeted by the intervention (teamwork, digital competence, communication skills, and satisfaction). Evaluation procedures for each instrument are described below.

Teamwork instrument

The instrument used to assess teamwork skills was the RUTE scale (Teamwork Questionnaire), which measures seven key dimensions (dim) of teamwork: goal orientation (dim1), involvement (dim2), participation (dim3), task fulfillment (dim4), coordination (dim5), conflict resolution (dim6), and consensus building (dim7). Each item is rated from 1 to 4, representing increasing levels of skill acquisition (Table 1). Prior to its use, the instrument was explained to students during class time, including the meaning of each dimension and the interpretation of the response levels, and was completed under instructor supervision.

For each RUTE dimension, students' responses were combined to generate a dimension-level score.

This validated instrument developed by Torelló et al. [22] showed good internal consistency in higher education samples (Cronbach's $\alpha = 0.86$). In the present sample, Cronbach's alpha values ranged from 0.78 to 0.84 across measurement points, confirming adequate reliability.

This instrument also allows a peer-assessment (co-evaluation), which means that each student was randomly assigned to evaluate one teammate using the same RUTE scale, allowing comparison between self- and peer-perceived performance and providing an external perspective to support validity. For the co-evaluation, each participant's self-assessment score was directly compared with the score assigned by a peer evaluator for the same dimension, enabling paired self–peer comparisons in addition to longitudinal and gender-based analyses.

Digital & communication skills questionnaire (D&CSQ)

Conversely, six Likert-scale items that examined important facets of students' digital literacy—such as information evaluation, content organisation, online collaboration, privacy awareness, and creative expression through digital media—were used to evaluate their digital competencies. These items are adapted from the IKANOS self-assessment test [25], aligned with the European Digital Competence Framework (DigComp) [26], the Australian Digital Capability Framework (ADCF) [27] and the DQ Framework [28], which is formalized as a global standard by the IEEE—an international leader in technology and standardization [29].

This questionnaire included the evaluation of communication skills through a three-item Likert-scale focused on students' self-perception of their performance during presentations or audiovisual assignments. The items addressed both verbal (clarity of speech, grammatical accuracy, content mastery) and non-verbal aspects (posture, eye contact, volume of voice, expressive delivery). This short ad hoc scale is based on Rodríguez-Gallego's Oral Presentation Rubric [30].

Together, these nine items comprise the D&CSQ, which is detailed in Table 2.

For the Digital and Communication Skills Questionnaire (D&CSQ), item-level responses were analysed individually to capture changes over time in specific digital and communication competencies, rather than computing a single composite score. This approach allowed a more fine-grained assessment of short- and long-term changes across the different skill domains addressed by the instrument.

Given that the D&CSQ combined distinct yet conceptually related dimensions rather than forming a single latent construct, internal consistency was not calculated. Instead, content and theoretical validity were ensured through the selection and adaptation of items from established frameworks and prior validated instruments. The instrument was reviewed by two faculty members with expertise in educational technology and communication to confirm its clarity and relevance for first-year nursing students.

Satisfaction survey

The satisfaction questionnaire consisted of nine Likert-scale items and one open-ended question, allowing students to express any additional comments about the experience (Fig. 1).

The closed-ended items assessed students' perceptions regarding the overall experience with the activity, including their perceived learning, enjoyment, engagement,

Table 1 Teamwork questionnaire. Description of teamwork dimensions included in the RUTE scale and acquisition level of each dimension ranges from 1 (lowest) to 4 (highest)

Teamwork questionnaire		
Dimensions	**Items**	**Level of acquisition**
1 **Performance according to objectives** The ability to stay focused on achieving the team's goals effectively	I guide my actions without considering the team's objectives	1
	I guide my actions according to the objectives, but do not create synergies within the team	2
	I guide my actions according to the objectives, creating synergies within the team	3
	I act in line with the objectives, creating synergies within the team and anticipating new objectives	4
2 **Involvement in the team** The degree of commitment, interest, and emotional investment in team activities	I do not participate in team tasks	1
	I carry out my tasks within the team without supporting others	2
	I complete my task, and support the activities of the rest of the team.	3
	I complete my tasks, support and encourage the activities of the rest of the team.	4
3 **Active participation in tasks** How actively and consistently the student engages in group discussions and task execution	I do not contribute to decision-making	1
	I make contributions during execution that do not affect decision-making	2
	I provide relevant alternatives for making adjustments during the execution process	3
	I synthesize relevant input from the team to make adjustments during the execution process	4
4 **Fulfillment of assigned tasks** The extent to which students take responsibility and complete their individual duties on time	I need help and supervision to be able to carry out tasks	1
	I carry out tasks following the established plan	2
	I carry out tasks according to the plan and adjust them when necessary	3
	I carry out tasks according to the plan, make adjustments when necessary, and help my colleagues with theirs.	4
5 **Coordination with other team members** The ability to collaborate smoothly, adapt to others, and maintain coherence in group work	I carry out tasks independently of the team	1
	I coordinate only when prompted by other team members	2
	I take the initiative to coordinate with others	3
	I take the initiative to coordinate with others and promote the collective work of the entire team	4
6 **Conflict resolution** How effectively students manage disagreements and contribute to a constructive team climate	I do not resolve existing conflicts	1
	I resolve conflicts effectively but not efficiently	2
	I resolve conflicts efficiently	3
	I resolve conflicts efficiently by involving team members and enhancing their performance.	4
7 **Achievement of agreements** The capacity to build consensus, reach joint decisions, and align team perspectives	I prevent the achievement of agreements	1
	I facilitate the achievement of agreements within the team.	2
	I proactively reach agreements	3
	I proactively reach agreements and formalize them.	4

Table 2 Digital&Communication skills questionnaire (D&CSQ). Each item was rated from 1 to 4, where: 1-Never; 2-Sometimes; 3-Frequently; 4-Always

	Digital & communication skills questionnaire (D&CSQ)
Digital skills	1. I critically check if the information I find on the internet is reliable.
	2. I know how to organize digital content (such as documents, images, videos) using folders or tags to find them later making grammatical errors and demonstrate a complete understanding of the topic
	3. I share what I learn with colleagues and peers in shared online spaces.
	4. I am aware I should ask for permission before publishing or sharing photos in which people appear
	5. I know how to express myself by creating digital content on the internet (for example, blog posts, YouTube videos)
	6. I know how to create something new by blending different types of content (for example, text and images)
Communication skills	When doing a presentation or creating an audiovisual resource, I believe…
	7. … I control the volume of my voice, my posture, and maintain eye contact with the audience
	8. … I speak clearly without making grammatical errors and demonstrate a complete understanding of the topic
	9. … I adhere to the time limit and show enthusiasm in what I explain

Questionnaire to assess students' satisfaction with the learning experience

Responses are rated on a 5-point Likert scale:

1 – Strongly disagree / Not at all satisfactory
2 – Disagree / Slightly satisfactory
3 – Neither agree nor disagree / Adequate
4 – Somewhat agree / Satisfactory
5 – Strongly agree / Very satisfactory

ITEM	DESCRIPTION	1	2	3	4	5
1	The organization of the activity was appropriate.					
2	The space where the activity took place was adequate.					
3	The instructors conveyed the information clearly.					
4	The experience was useful to me.					
5	I have acquired/improved my digital competencies.					
6	I have acquired/improved my academic competencies (knowledge of the subject).					
7	I have acquired/improved my communication skills.					
8	I have acquired/improved my teamwork skills.					
9	Overall satisfaction with the experience.					
10	Write any comments you consider relevant (e.g., what could be improved in the experience, whether you would like it to be implemented in other courses, whether you would be interested in creating a channel or Instagram account or another social media platform to share all the projects, whether you find the joint evaluation by teachers and peers appropriate, etc.).					

Fig. 1 Satisfaction survey

and improvement in key competencies such as communication, teamwork, and digital skills. In this way, it complemented the limited scope of the brief scale measuring digital and oral communication performance, while also confirming the teamwork results.

Video production assessment

During the video-presentation sessions, students used a standardized evaluation rubric (35% communication, 25% digital, 40% specific competencies) to evaluate classmates' projects on a 0–10 scale (Fig. 2).

The rubric was shared online, and the videos were assessed in real-time by both the instructor and all participating students. The peer-assessment score represented the group consensus average, while the instructor completed the same rubric independently. The final score for each group was calculated as a weighted average, with the teacher's assessment contributing 60% and the peer assessment 40%. This weighting ensured that the final grade reflected both the students' participatory evaluation and the instructor's expert judgment. The rubric was shared in advance with all participants and used as a formative and summative tool to promote transparency and self-reflection.

Data collection

Data were collected at three time points: T1 (baseline; before the intervention), T2 (post-intervention; immediately after the video presentation sessions) and T3 (follow-up; one year later, at the beginning of the students' second academic year).

Students completed both Teamwork and D&CS questionnaires at the three previously indicated time points (T1, T2, and T3). The teamwork peer assessment was only complete once, in T2, just like the satisfaction survey.

Data collection was integrated into class activities and conducted using online questionnaires during class hours, except questionnaires at T3, which were administered online, but outside class hours. No additional demographic variables beyond age and gender were collected.

Participant attrition occurred at both post-intervention (T2) and follow-up (T3) stages due to nonresponse to the online forms. Students with incomplete data at any time point were excluded from the corresponding analyses. For the peer-assessment component, participants without a valid peer evaluation were also excluded. The flowchart is shown in Fig. 3.

Data analysis

Descriptive statistics (mean, standard deviation, frequencies, and percentages) were calculated for all variables. The Shapiro–Wilk test was used to assess normality. Because data were non-normally distributed, nonparametric tests were applied. Inferential analyses included Wilcoxon signed-rank tests for within-subject comparisons (T1–T2, T2–T3, T1–T3), Mann–Whitney U tests for gender comparisons at each time point and Wilcoxon signed-rank tests for comparing self- and peer-assessment scores. The significance level was set at $p < 0.05$. All analyses were performed using R software (Version 4.0.3).

PROCEDURE

Score from 1 to 10 in each section, taking into account the degree of fulfillment of the skills according to the indicated criteria. The whole group must agree on the grade to be assigned to the rest of the classmates' groups.

		0	1	2	3	4	5	6	7	8	9	10
Communicative Skills (35%)	Expresses ideas clearly											
	Uses appropriate language											
	Conveys information fluently											
	Body language supports communication											
Digital Competencies (25%)	Audio is clear and easy to understand											
	Visual content is presented appropriately											
	The presentation is original											
Specific Competencies (40%)	Uses technical language correctly											
	The explained procedure is accurate											
	Makes no conceptual or technical errors											

Fig. 2 Rubric used for the evaluation of the presented video

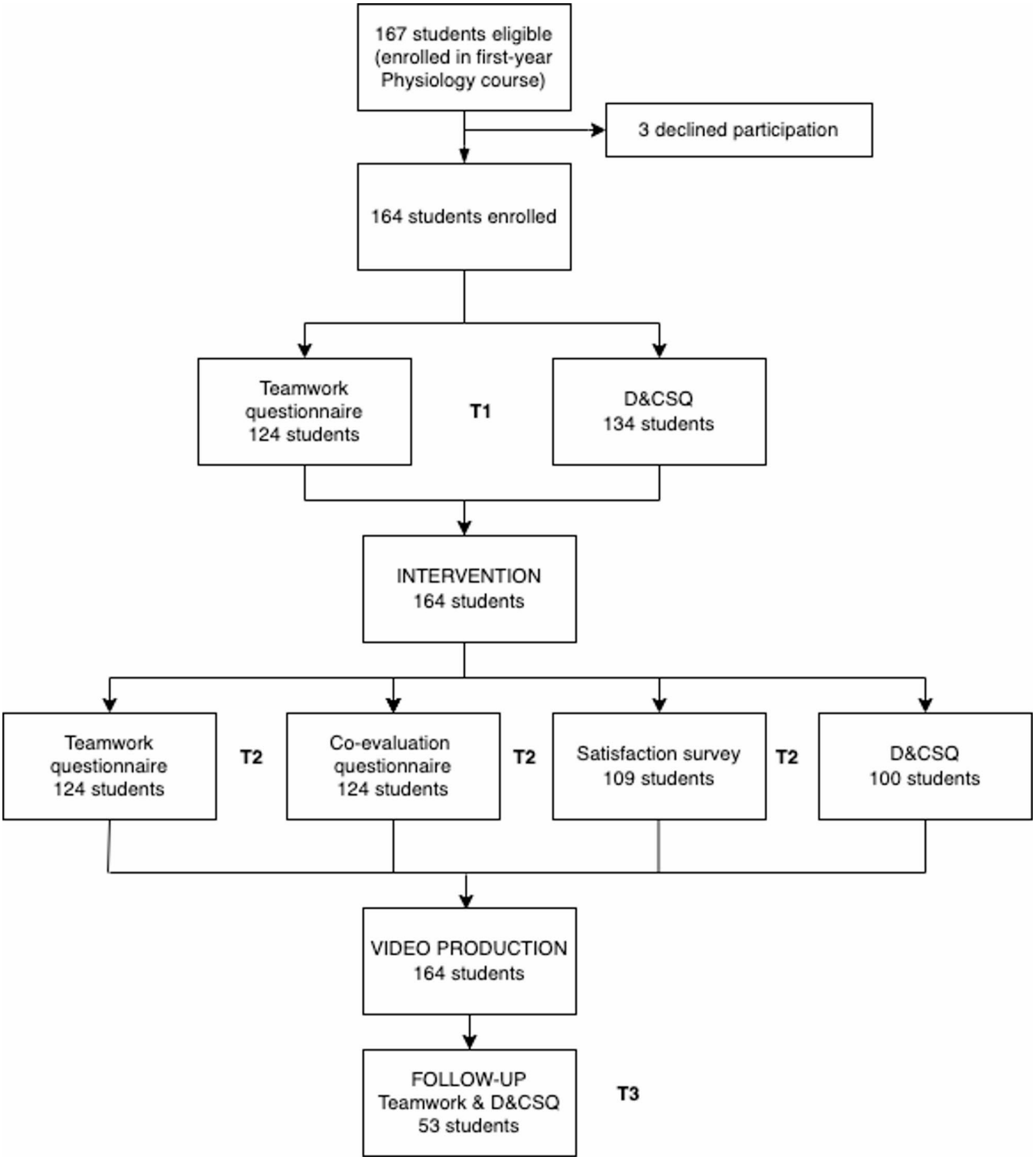

Fig. 3 Flowchart illustrating the sequence of data collection and student participation throughout the different phases of the study: T1 (pre-intervention), T2 (post-intervention), and T3 (follow-up one year after the intervention). D&CSQ: Digital and Communication Skills Questionnaire

No formal power calculation was conducted; the sample size corresponded to the total accessible cohort. Cases with missing data were excluded from the relevant analyses.

Instruments´ internal consistency was assessed using Cronbach's alpha.

Results

Implementation

Of the 167 eligible students, 164 participated in the intervention (98.2%), indicating an excellent participation rate. Attendance to the seven practical sessions was also very high (mean 98%).

A total of 27 video projects were created, and all groups successfully met the established requirements and deadlines outlined in the course calendar.

Teamwork self-assessment

The questionnaire on teamwork competencies was completed by 124 students at T1 and T2. The T3 follow-up evaluation was conducted with 54 students.

Analysis of the seven dimensions assessed over time revealed significant differences across the different time points as well as between genders (see Supplementary Table 1).

Two dimensions showed statistically significant differences between the T1-T2 and T1-T3 measurements: 3-Active Participation in Tasks ($p = 0.01$ and 0.006, respectively) and 7-Achievement of Agreements ($p = 0.001$ and $p = 0.01$, respectively). Dim 5-Coordination with Other Team Members also showed a significant improvement, but only from T1 to T3 ($p = 0.02$). Figure 4 presents the evolution over time of the dimensions that showed statistically significant changes.

A moderate to high degree of self-perceived teamwork ability was observed at baseline (T1), with scores concentrated in the upper range of the scale (3–4 on a 1–4 scale), indicating a ceiling effect in several dimensions. Nevertheless, comparatively lower baseline ratings were observed in Performance According to Objectives (dimension 1), Active Participation (dimension 3), and Achievement of Agreements (dimension 7), whereas Involvement in the Team showed consistently high initial ratings. Despite this ceiling effect, a positive progression over time was observed across all dimensions.

In terms of gender disparities, dim 4 showed a significant difference before the intervention ($p = 0.01$), with female participants rating themselves as more capable of completing tasks than their male counterparts. After the intervention, though, this difference was not noticed. Female students mirrored the overall sample's trends in showing significant improvements in dimensions 3 and 7 over time ($p < 0.01$ for all time comparisons). Although both genders improved, women tended to rate themselves slightly lower in Active Participation and slightly higher in Achievement of Agreements. A significant gender difference in Coordination (dim 5) also emerged at T3, with women reporting higher scores ($p = 0.01$).

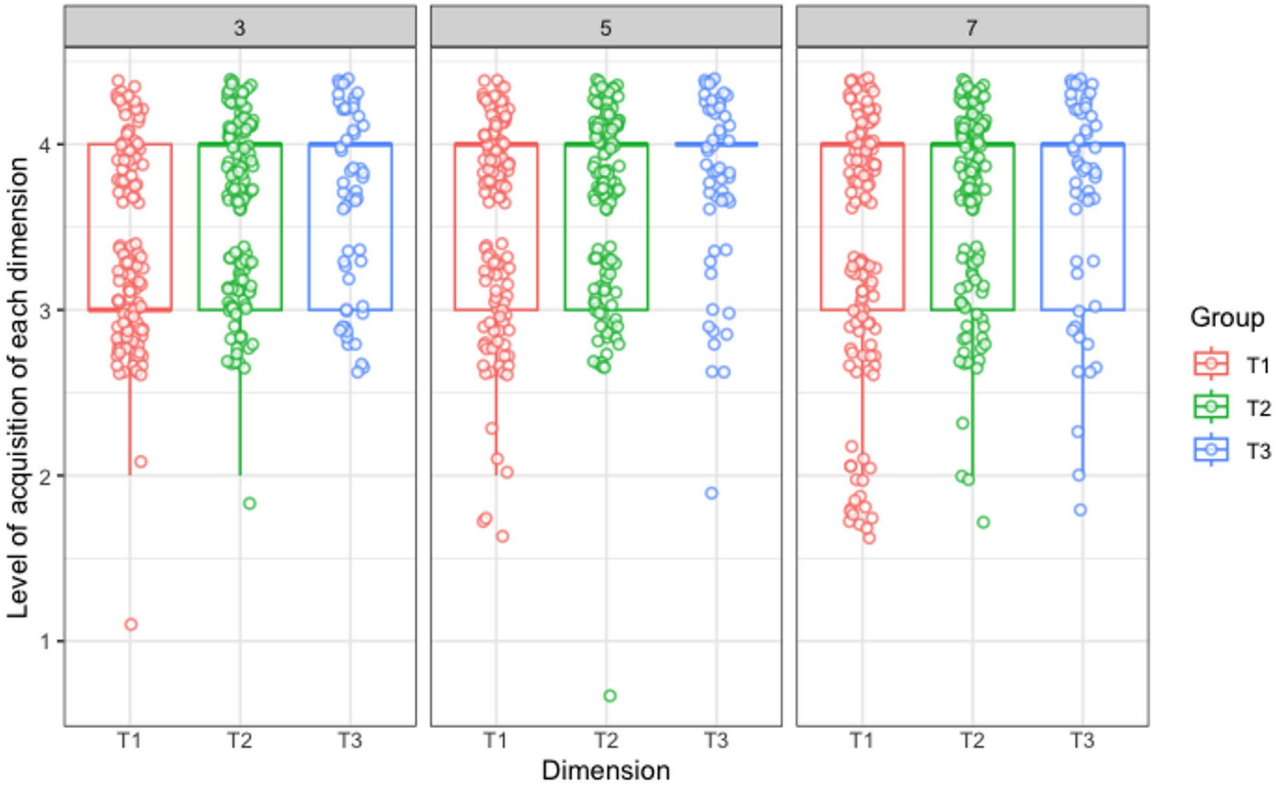

Fig. 4 Self-assessed teamwork scores over time for the dimensions showing statistically significant changes: Active participation in tasks (dim 3), Coordination with other team members (dim 5), and Achievement of agreements (dim 7). Scores are shown at baseline (T1), post-intervention (T2), and one-year follow-up (T3). Data are presented as boxplots showing medians and interquartile ranges, with individual student scores overlaid as jittered points to illustrate score distributions. The RUTE scale ranges from 1 (lowest level of competence acquisition) to 4 (highest). Non-parametric within-subject comparisons were conducted using Wilcoxon signed-rank tests

Teamwork peer-assessment (co-evaluation)

At T2, 124 students completed both a self-assessment and a peer evaluation using the same instrument. The same questionnaire was administered; self-ratings were compared with peer ratings (see Supplementary Table 2). Although both the teamwork and the peer-assessment questionnaires were completed by the same number of students ($n = 124$), the participants were not entirely identical across both; some students took part in one, but not the other.

With statistically significant differences observed in dimensions 3 (Active Participation in Tasks), 5 (Coordination with Other Team Members), 6 (Conflict Resolution), and 7 (Achievement of Agreements), the results presented in Fig. 5 showed a clear and consistent trend: students rated their peers higher than they rated themselves. This pattern suggests a systematic underestimation of one's own performance compared with peer perceptions, despite self-assessment scores being concentrated in the upper range of the scale.

Gender analysis showed a significant difference in self-ratings for dim 4, where female students rated themselves higher than male students in fulfilling assigned tasks ($p = 0.01$). This pattern, consistent with pre-intervention self-assessments, was not evident immediately post-intervention. In the peer assessment for dim 7-Achievement of Agreements, the results showed that, compared to male students, females tended to rate their peers higher.

Digital and communicative skills

A total of 134 students completed the D&CSQ at T1, 100 at T2, and 53 at T3, with no significant differences in gender distribution across time points ($p = 0.454$).

Results are shown in Supplementary Table 3. Regarding initial self-perception (T1), the lowest self-rated was item 5 (ability to express oneself through digital content creation), particularly among female students. Similarly, item 3 (information sharing with others) scored low, especially among men ($p = 0.01$). The highest baseline score was for item 4 (awareness of needing permission before publishing images of others).

Following the intervention, in the short term (T1 vs. T2), students reported significantly higher self-ratings in five of the six digital skill items, except item 3. However, at T3, item 3 showed marked improvement compared to both at T1 ($p < 0.001$) and at T2 ($p = 0.03$). Items 5 and 6 (ability to create using different file types) also improved

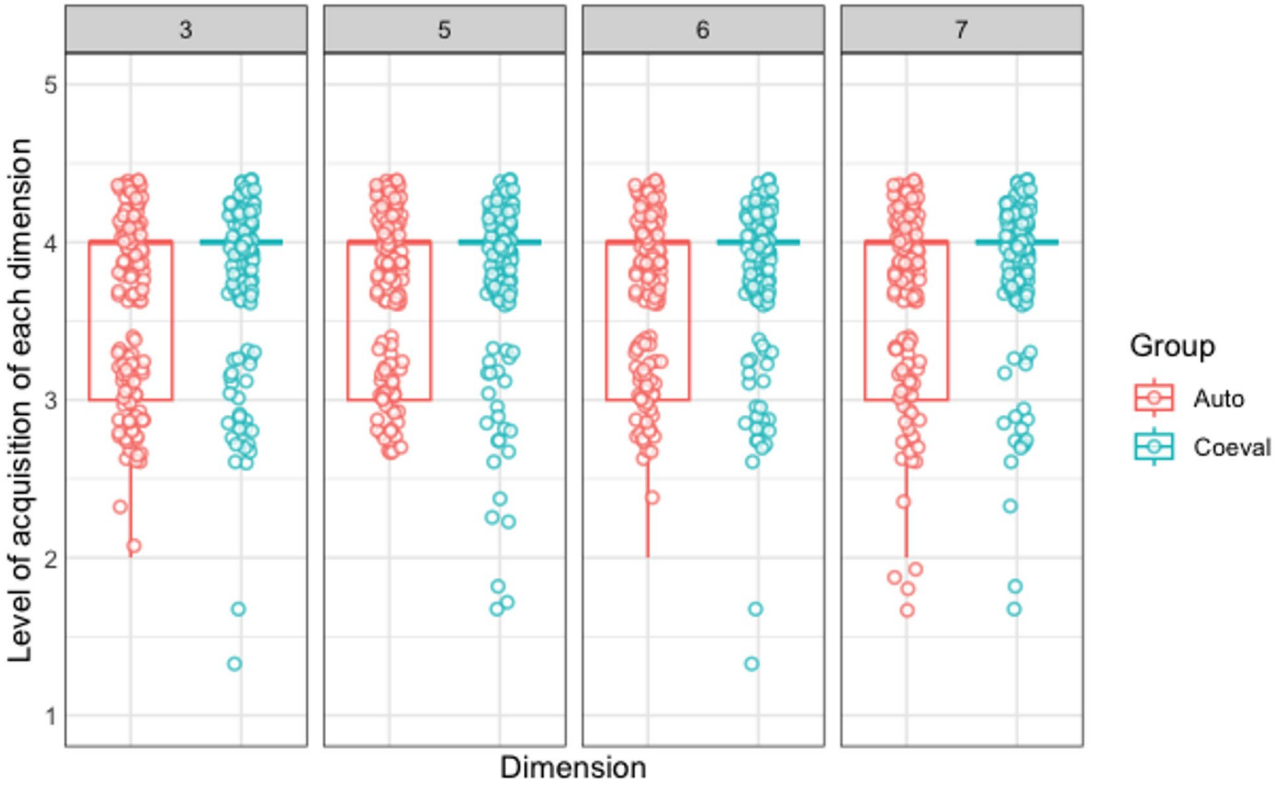

Fig. 5 Co-evaluation results. Comparison between self-assessment and peer-assessment scores for the teamwork dimensions showing statistically significant differences after the intervention. Individual student scores are displayed as dot plots to illustrate the distribution of ratings for each assessment type. Dimensions shown: 3. Active participation in tasks; 5. Coordination with other team members; 6. Conflict resolution; 7. Achievement of agreements. Scores range from 1 (lowest level of competence acquisition) to 4 (highest)

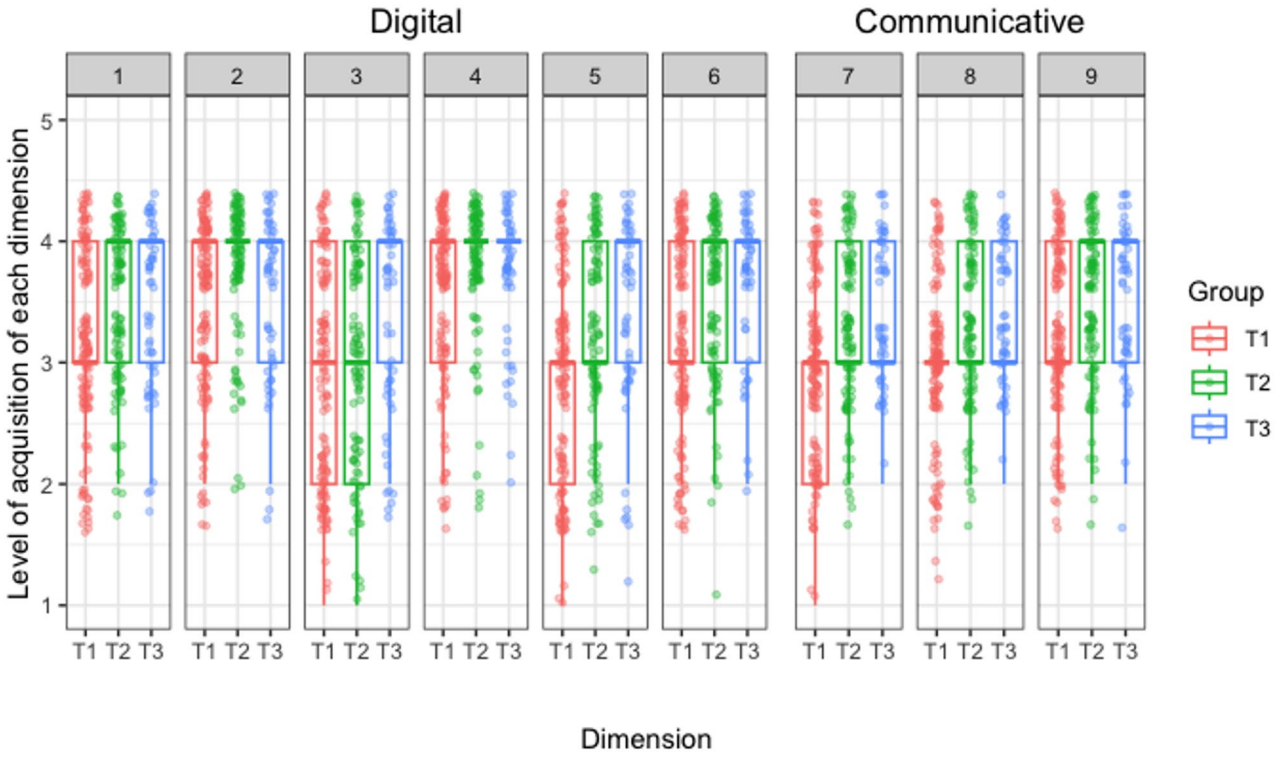

Fig. 6 Digital and communication skills questionnaire (D&CSQ) results. Self-assessment of digital and communicative competencies before (T1), after (T2), and one year after the intervention (T3). Digital items: (1) Use of digital tools, (2) Collaboration through technology, (3) Critical evaluation of digital sources, (4) Content creation, (5) Ethical use of technology, (6) Digital communication. Communicative items: (7) Clarity of expression, (8) Active listening, (9) Adaptation to audience. Each item was rated on a 4-point scale:1-Never; 2-Sometimes; 3-Frequently; 4-Always. Statistical analyses were conducted using non-parametric tests, and significant differences across time points are reported in the Supplementary Table 3

significantly over time. In both, male students rated themselves higher than females at T3 (item 5, $p = 0.04$; item 6, $p = 0.02$).

A sustained improvement was also observed in item 1 (critical analysis of online content reliability), primarily among male participants ($p = 0.01$). In contrast, items 2 (digital content organisation) and 4 (permission before publishing others' images) did not show significant changes from T1 to T3.

Regarding communicative skills, the lowest initial score at T1 was for item 7 (non-verbal communication: voice, posture, eye contact), particularly among female students ($p = 0.04$). In contrast, the highest initial self-rating was found in item 9, which refers to time management and the ability to deliver enthusiastic speeches.

As it is shown in Fig. 6, after the intervention, students perceived short-term improvements (T1 vs. T2) in all three communicative skills assessed (items 7–9). One year later (T1 vs. T3), students continued to report improvements in non-verbal communication (item 7) and in their ability to speak appropriately on the topic (item 8). However, only male participants reported maintaining improvements in time management and enthusiasm (item 9).

Satisfaction survey

The intervention was rated very positively by participants ($n = 109$), with high scores for organisation (4.7 ± 0.55), adequacy of the space (4.72 ± 0.56), and clarity of instruction (4.72 ± 0.5). Overall satisfaction reached a mean of 4.58 ± 0.63, and students reported perceived improvement in key competencies, particularly teamwork (4.52 ± 0.7), academic (4.49 ± 0.69), and communication skills (4.3 ± 0.82). Results are shown in Supplementary Table 4.

Qualitative analysis of open-ended responses reinforced these findings, highlighting the activity's dynamic, engaging and practical nature, as well as its potential transferability to other courses. A single area for improvement identified was related to the peer evaluation system using shared rubrics (data not shown).

Discussion

This study aimed to evaluate the long-term effectiveness of a student-led video-based intervention in fostering teamwork, communication, and digital competencies among first-year nursing students, as well as to explore potential gender-related differences. Across the three soft skill domains, improvements were evident immediately after the intervention and, in several cases, were

sustained one year later. These results suggest that embedding collaborative video projects within practical coursework can support both immediate and longer-term development of key soft skills in nursing education.

By engaging students simultaneously in group coordination, verbal and non-verbal communication, and digital content creation, the intervention provided a multifaceted learning experience that supported experiential skill development without requiring high technological complexity. This approach offers a flexible and replicable model for embedding soft skills training within regular practical teaching [31].

Teamwork skills showed notable increases in active participation and consensus-building—dimensions 3 and 7 that are especially relevant in clinical settings where decision-making is shared, suggesting that the intervention had both short- and longer-term positive effects on both dimensions. In contrast, coordination with peers (dim 5) showed a delayed improvement, suggesting that some interpersonal processes consolidate more gradually over time, as also reported in studies linking team trust and communication to performance [32].

Students also reported feeling more competent in terms of digital skills, especially in the areas of responsible digital behaviour and content creation. However, the ability to share content with peers only improved significantly over time. The study conducted by Johanson et al. supports our findings [33] suggesting that while some digital competencies can be developed through structured activities, others—such as digital collaboration—depend on prolonged engagement, confidence with tools, and the formation of sharing habits.

Additionally, long-term retention of skills like organizing digital content or managing permissions was limited, likely due to students' low perception of the associated risks or relevance, as evidenced by Wright et al. [34].

Additionally, there were consistent improvements in both verbal and nonverbal communication skills. Early training should emphasize these skills because they are essential to nursing practice, particularly nonverbal communication, which is crucial when caring for young, elderly, or cognitively challenged patients [35]. The need for specialized reinforcement techniques is highlighted by the fact that, although verbal communication was retained generally, certain student profiles improved in time management and expressiveness [36].

These results provide information about which soft skills should be reinforced over time and which need more emphasis early in the curriculum. While active participation or communication expressiveness may react more quickly, skills like coordination or content sharing appear to develop gradually and benefit from repeated exposure.

Gender differences and perceptions

Gender-based analysis revealed important nuances across all soft skill domains. Related to teamwork abilities, a baseline difference was observed related to complete their task on time (dim 4), where women rated themselves higher ($p = 0.01$). After the intervention, this difference disappeared, suggesting that the experience was effective in increasing men's self-perception levels to align with those of women. It is important to note that, since self-perception scores started at a high baseline and were already near the maximum level, there was limited room for further improvement.

We also found gender differences in the same dimensions as observed in the overall group. In both the T1-T2 and T1-T3 comparisons, female students reported a lower self-perception in their level of active involvement in group tasks (dim 3), but a higher perception in their ability to reach agreements and make collective decisions (dim 7). Notably, in this last dimension, women showed further improvement in the T2-T3 interval. However, these differences may be partly explained by the smaller size of the male group (n = 12) compared to the female group (n = 42) during the T3 period. In other studies, with more balanced samples, female students have been found to outperform males in teamwork skills [37]. Nonetheless, this underrepresentation of male students mirrors the broader gender imbalance observed in the nursing profession in many countries, where the workforce is predominantly female.

Additionally, female students rated themselves higher in their ability to complete the tasks assigned to them within the group (dim 4; p = 0.01). It's interesting to note that they also gave their male peers higher ratings for their capacity to come to consensus and decide as a group when working in a team (dim 7; p = 0.02). These results might be the result of ingrained prejudices and underlying social perceptions that affect how students evaluate others and themselves in group situations. Research indicates that even though women acknowledge their own efforts, they may undervalue the contributions of other women because they believe that male contributions are more decisive or goal-oriented [38].

However, other studies have shown the opposite trend—where women tend to evaluate other women more positively—while men who strongly identify with their gender may rate female peers less favourably, even in the presence of objectively strong team performance [18]. Understanding potential gender-based differences in how teamwork competencies are expressed and assessed is crucial for developing more inclusive and equitable learning strategies, especially in early academic stages when students are still shaping their roles within collaborative environments [21, 39].

Our findings demonstrated that, in terms of digital competencies, male students sustained long-term gains in their capacity to assess the credibility of online content critically, while female students did not show this improvement. Men tend to perceive themselves as more competent in the use of digital technologies and in the technical and pedagogical aspects of digital content analysis, which is consistent with earlier research that suggests a persistent gender gap in digital literacy and critical thinking [40]. In contrast, women have demonstrated a greater affinity for using mobile devices and social media, as well as higher scores in attitudes toward digital technologies [41]. These studies suggest that men tend to maintain and perceive greater competencies in technology management and critical skills over the long term, whereas women, although displaying a positive attitude toward technology, report lower levels of self-perception in critical digital competencies.

Finally, improvements in verbal communication were also maintained over time, though time management and enthusiasm (item 9) were only retained among male students. Since time management has been linked to enhanced clinical competence, reduced anxiety, and better academic engagement, its development should be supported with specific training activities [36].

These gender-related patterns support that beyond technical training, nursing education should also address underlying perceptions and biases that affect how students assess and express their competencies. Creating inclusive, balanced group dynamics and diversifying roles within collaborative tasks may help challenge stereotypes and support more equitable skill development.

Limitations

One of the considerations in this study is the reduction in sample size over time. Additionally, although improvements in teamwork skills were observed, they could partially reflect natural developmental changes or limited clinical exposure. However, it is important to note that participants were first-year students at the time of the intervention, and during their second year—when the follow-up was conducted—they had limited exposure to clinical placements, which reduces the likelihood that practice-based learning alone accounts for the changes observed. Selection bias is also possible, as students who remained in the study may have been more motivated or higher-performing.

Another limitation relates to the assessment approach used. Teamwork competencies were evaluated through student self-assessment and peer assessment, which primarily capture perceived rather than objectively observed performance. Although peer assessment was included to complement self-report and provide an additional perspective on collaborative behaviours, the absence of an instructor-based assessment limits the possibility of triangulating student perceptions with an external expert evaluation. Future studies could strengthen the validity of these findings by incorporating instructor ratings, structured observational checklists, or performance-based assessments of teamwork and communication skills.

In addition, gender-related analyses should be interpreted cautiously given the strong female predominance, which reflects the actual gender distribution in nursing education but limits the statistical power to detect differences.

Future research should consider strategies to improve follow-up retention and ensure more representative sampling.

Conclusions

This study demonstrates that integrating teamwork, communication, and digital skills within a single, collaborative learning experience is both feasible and effective for first-year nursing students. The collaborative video project served not only as a low-complexity simulation, but also as a pedagogically rich environment in which students could develop multiple soft skills simultaneously and meaningfully.

The sustained improvements observed—especially in active engagement, consensus-building, non-verbal communication, and digital content creation—highlight the potential of experiential, interdisciplinary activities to promote long-term skill retention. Furthermore, the need for long-term reinforcement of soft skills across the nursing curriculum is highlighted by the delayed development of some competencies, such as peer coordination and digital content sharing.

While structured learning experiences can help equalize self-perceptions and participation, hidden social norms and digital confidence gaps may still have an impact on student performance and peer evaluations, according to gender differences seen across all soft skill domains. Addressing these imbalances through inclusive group design, reflective practices, and critical discussion about roles and biases can further support equitable skill development.

Overall, this integrative approach offers a replicable model for embedding essential soft skills into nursing education, fostering the early formation of professional identity, and preparing students for collaborative, technology-enhanced healthcare environments.

Abbreviations

ADCF	Australian Digital Capability Framework
CEICA	Comité de Ética de la Investigación de Aragón
D&CSQ	Digital and Communication Skills Questionnaire
DIGCOMP	Digital Competence Framework for Citizens
DQ	Digital Intelligence Framework
IEEE	Institute of Electrical and Electronics Engineers
LTSES	Leadership/Teamwork Self-Efficacy Scale

RUTE	Teamwork Questionnaire (Rúbrica de Trabajo en Equipo)
TIDieR	Template for Intervention Description and Replication
TREND	Transparent Reporting of Evaluations with Nonrandomized Designs
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions
All authors have read and approved the final manuscript. PGT: Formal analysis, Investigation, Software, Visualization, Writing – original draft. MC: Conceptualization, Investigation, Writing – original draft, Writing – review and editing. SGA: Investigation, Software, Visualization. JF: Data curation, Methodology, Investigation, Resources, Funding acquisition, Writing – review and editing. ABMM: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review and editing.

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Data availability
The dataset supporting the conclusions of this article is available in the Zenodo repository, [https://doi.org/10.5281/zenodo.12921566].

Declarations

Ethics approval and consent to participate
The study was reviewed by the Research Ethics Committee of Aragon (CEICA), which confirmed that formal approval was not required as the data were educational and non-clinical in nature. Institutional authorization for data collection and management was granted by the Data Protection Unit of [University name withheld for peer review] (RAT 2022 – 267). All participants were informed of the study objectives, assured of anonymity, and provided informed consent prior to participation. Participation was voluntary, and students were informed that declining to participate would not affect their academic evaluation. All procedures were conducted in accordance with the ethical principles of the 1975 Declaration of Helsinki and its later amendments.

Consent for publication
All authors have reviewed and approved the final version of the manuscript and consent to its publication.

Competing interests
The authors declare no competing interests.

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References

1. Digital health and care - European Commission. https://health.ec.europa.eu/ehealth-digital-health-and-care/digital-health-and-care_en. Accessed 27 Jun 2025.
2. Driving the future of digital health | American Medical Association. https://www.ama-assn.org/practice-management/digital-health/driving-future-digital-health. Accessed 27 Jun 2025.
3. Australia. Safe, seamless and secure: evolving health and care to meet the needs of modern.
4. Vaseghi F, Yarmohammadian MH, Raeisi A. Interprofessional collaboration competencies in the health system: A systematic review. Iran J Nurs Midwifery Res. 2022;27:496. https://doi.org/10.4103/IJNMR.IJNMR_476_21.
5. Baek H, Han K, Cho H, Ju J. Nursing teamwork is essential in promoting patient-centered care: a cross-sectional study. BMC Nurs. 2023;22:1–8. https://doi.org/10.1186/S12912-023-01592-3.
6. Bragadóttir H, Kalisch BJ, Flygenring BG, Tryggvadóttir GB. The relationship of nursing teamwork and job satisfaction in hospitals. SAGE Open Nurs. 2023;9. https://doi.org/10.1177/23779608231175027.
7. Burton-Jones A, Akhlaghpour S, Ayre S, Barde P, Staib A, Sullivan C. Changing the conversation on evaluating digital transformation in healthcare: insights from an institutional analysis. Inf Organ. 2020;30:100255. https://doi.org/10.1016/j.infoandorg.2019.100255.
8. Rosen MA, DiazGranados D, Dietz AS, Benishek LE, Thompson D, Pronovost PJ, et al. Teamwork in healthcare: key discoveries enabling Safer, High-Quality care. Am Psychol. 2018;73:433. https://doi.org/10.1037/AMP0000298.
9. Dartiguelongue JB, Cafiero PJ. Communication in health care teams. Arch Argent Pediatr. 2021;119:E589–93. https://doi.org/10.5546/AAP.2021.ENG.E589.
10. Hastie CR. TeamUP: an approach to developing teamwork skills in undergraduate midwifery students. Midwifery. 2018;58:93–5. https://doi.org/10.1016/J.MIDW.2017.12.026.
11. Tischendorf T, Hasseler M, Schaal T, Ruppert SN, Marchwacka M, Heitmann-Möller A, et al. Developing digital competencies of nursing professionals in continuing education and training – a scoping review. Front Med. 2024;11. https://doi.org/10.3389/fmed.2024.1358398.
12. Abou Hashish EA, Alnajjar H. Digital proficiency: assessing knowledge, attitudes, and skills in digital transformation, health literacy, and artificial intelligence among university nursing students. BMC Med Educ. 2024;24:1–11. https://doi.org/10.1186/S12909-024-05482-3.
13. Clohessy S, Arvanitis TN, Rashid U, Craddock C, Evans M, Toro CT, et al. Using digital tools in clinical, health and social care research: a mixed-methods study of UK stakeholders. BMJ Open. 2024;14:e076613. https://doi.org/10.1136/BMJOPEN-2023-076613.
14. Karlsen T, Hall-Lord ML, Wangensteen S, Ballangrud R. Bachelor of nursing students' attitudes toward teamwork in healthcare: the impact of implementing a teamSTEPPS® team training programme — A longitudinal, quasi-experimental study. Nurse Educ Today. 2022;108:105180. https://doi.org/10.1016/J.NEDT.2021.105180.
15. Soe T, Jamaludin S, Said Nurumal M, Ahmad N, Aesah S, Muhammad N, et al. Soft skills elements in structured clinical skill assessment: a qualitative study. Bali Med J. 2022;11:1666–74. https://doi.org/10.15562/bmj.v11i3.3721.
16. Planas-Lladó A, Feliu L, Arbat G, Pujol J, Suñol JJ, Castro F, et al. An analysis of teamwork based on self and peer evaluation in higher education. Assess Eval High Educ. 2021;46:191–207. https://doi.org/10.1080/02602938.2020.1763254.
17. De Paola M, Gioia F, Scoppa V. Teamwork, leadership and gender. IZA; 2022.
18. Hauff N. Empowering teamwork: a gender perspective. Màster Oficial - Empresa Internacional / International Business; 2023.
19. Deemer ED, Sharma P, Xu C. Leadership/Teamwork Self-Efficacy scale: longitudinal confirmatory factor analysis in the context of an energy science

intervention. J Career Dev. 2022;49:585–99. https://doi.org/10.1177/08948453209538899/FORMAT/EPUB.
20. Mondaca F, Jiménez Lira C, Ivonne Aguirre S, Josué Nájera R, Concepción Soto M, Alonso González M, et al. Self-efficacy in teamwork and entrepreneurship in university students from social and health sciences programmes. Eur Sci J ESJ. 2020;16:74–74. https://doi.org/10.19044/ESJ.2020.V16N5P74.
21. Başoğul C. Conflict management and teamwork in workplace from the perspective of nurses. Perspect Psychiatr Care. 2021;57:610–9. https://doi.org/10.1111/PPC.12584.
22. Óscar M, Torelló. Georgina París Mañas CT. El trabajo en equipo: Dominio competencial en diferentes grados de la Universitat Autònoma de Barcelona y de la Universitat de Lleida - Dialnet. Revista de ciències de l'educació. 2016;55–66.
23. Zajac S, Woods A, Tannenbaum S, Salas E, Holladay CL. Overcoming challenges to teamwork in healthcare: A team effectiveness framework and Evidence-Based guidance. Front Commun (Lausanne). 2021;6:606445. https://doi.org/10.3389/FCOMM.2021.606445/BIBTEX.
24. World Health Organization. Global strategic directions for nursing and midwifery 2021–2025. 2021;292:30. https://www.who.int/publications/i/item/9789240033863. Accessed 14 Oct 2025.
25. Home. - Ikanos. https://ikanos.eus/. Accessed 14 Oct 2025.
26. R V, S K, Y P. DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes. Luxembourg (Luxembourg): Publications Office of the European Union; 2022. https://doi.org/10.2760/115376 (online),10.2760/490274 (print).
27. Australian Digital Capability Framework - Department of Employment and Workplace Relations, Government A. https://www.dewr.gov.au/skills-reform/resources/australian-digital-capability-framework. Accessed 14 Oct 2025.
28. DQ Framework | DQ Institute. https://live.dqinstitute.org/dq-framework/. Accessed 14 Oct 2025.
29. IEEE SA, -. IEEE 3527.1–2020. https://standards.ieee.org/ieee/3527.1/7589/. Accessed 8 Jul 2025.
30. Rodríguez-Gallego MR, EVidenciar Competencias Con Rúbricas De EvaluaciÓN. Title: Skills Highlighted with Evaluation Rubrics. Escuela Abierta. 2014;17:117–34.
31. Widad A, Abdellah G. Strategies used to teach soft skills in undergraduate nursing education: A scoping review. J Prof Nurs. 2022;42:209–18. https://doi.org/10.1016/J.PROFNURS.2022.07.010.
32. Hoyle B, Taylor J. Zugic · Luca, Filho · Edson. Coordination cost and super-efficiency in teamwork: the role of communication, psychological states, cardiovascular responses, and brain rhythms. 2020;45:323–41. https://doi.org/10.1007/s10484-020-09479-8
33. Bergum Johanson L, Leming T, Johannessen BH, Solhaug T. Competence in digital interaction and communication—A study of First-Year preservice teachers' competence in digital interaction and communication at the start of their teacher education. Teacher Educ. 2023;58:270–88. https://doi.org/10.1080/08878730.2022.2122095.
34. Wright MC, Phillips-Bute BG, Petrusa ER, Griffin KL, Hobbs GW, Taekman JM. Assessing teamwork in medical education and practice: relating behavioural teamwork ratings and clinical performance. Med Teach. 2009;31:30–8. https://doi.org/10.1080/01421590802070853.
35. Pepper A, Dening KH. Person-centred communication with people with dementia. Nurs Older People. 2023. https://doi.org/10.7748/NOP.2023.E1430.35.
36. Behdarvand M, Ahmadi M, Khajeali N. Perceived clinical competence and predictive role of time management in nursing students. Nurse Educ Pract. 2023;72:103789. https://doi.org/10.1016/J.NEPR.2023.103789.
37. Santiago Gómez G, García López O, Vega ID, Duarte SR, Ponce SL. The impact of gender and academic degrees on the performance of transversal competencies in higher education students. Int J High Educ. 2022;11. https://doi.org/10.5430/ijhe.v11n3p148.
38. Schade M, Terkowsky C, Boettcher K, Inerle S, Kaufhold N, Herbrandt S, et al. Gender differences in teamwork and leadership within virtual engineering laboratories. Chem Ing Tech. 2024. https://doi.org/10.1002/cite.202300242.
39. Aghaie B, Heidari S, Abbasinia M, Abdoli M, Norouzadeh R, Shamali M. Teamwork competence and readiness of emergency nurses in the care of trauma patients: A multicenter cross-sectional study. Int Emerg Nurs. 2021;59. https://doi.org/10.1016/J.IENJ.2021.101073.
40. Fang G, Wang J, Chan PWK, Kalogeropoulos P. Understanding the gender divide in digital literacy in four European countries: A comprehensive decomposition analysis using unconditional quantile regression. Comput Educ. 2025;229:105264. https://doi.org/10.1016/J.COMPEDU.2025.105264.
41. Maon SN, Hassan NM, Jailani SFAK, Kassim ES. Gender differences in digital competence among secondary school students. Int J Interact Mob Technol. 2021;15:73–84. https://doi.org/10.3991/IJIM.V15I04.20197.

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