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Article

The Content Validity of the CHANT's French Translation and Cultural Adaptation: A Modified E-Delphi Study

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Abstract

Background/Objectives: Climate change is a major global health challenge with direct implications for public health. As frontline health professionals and agents of change, nurses must develop competencies to address climate-related health issues and implement sustainable practices. This study aimed to translate and culturally adapt the Climate, Health, and Nursing Tool (CHANT) into French and to assess its content validity using item-level (I-CVI) and scale-level (S-CVI) indices. The CHANT evaluates nurses' awareness, motivations, concerns, and self-reported behaviours related to climate change. A secondary objective was to examine potential associations between experts' sociodemographic and professional characteristics and their CVI ratings. **Methods**: A descriptive international study using a three-round modified e-Delphi approach was conducted between January and June 2025 in French-speaking regions of Switzerland, France, and Belgium. A multidisciplinary panel of experts in nursing, planetary health, and environmental sciences evaluated the relevance, clarity, and comprehensiveness of each item and response option, enabling iterative refinement. **Results**: Fifty-seven experts assessed the 12-item CHANT across three rounds. In Round 1, I-CVI ranged from 0.79 to 1.0 and S-CVI reached 0.935, with full consensus. In Round 2, I-CVI ranged from 0.71 to 1.0 and S-CVI was 0.91 (92% consensus), with one item not meeting the predefined threshold. In Round 3, I-CVI ranged from 0.82 to 1.0 and S-CVI returned to 0.935, confirming consensus. Cognitive debriefing further supported content validity. **Conclusions**: The validated French CHANT provides a robust tool to assess and support the development of climate-related competencies and eco-literacy in nursing education and practice.

Keywords: eco-literacy; eco-responsibility; eco-centricity; nursing sciences; climate change; psychometric validity; content validity index; e-Delphi survey; CHANT

1. Introduction

Climate change necessitates immediate and coordinated action across every sector of society. Building a climate-competent health workforce is essential to mitigating the health impacts of climate change. Nurses, who represent nearly 60% of the global health workforce and are among the most trusted health professionals, occupy a strategic position to influence public health and contribute to

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the United Nations' Sustainable Development Goals [1]. The International Council of Nurses Code of Ethics for Nurses emphasizes their responsibility to acquire and disseminate knowledge on the health and ecological consequences of climate change, while integrating environmentally responsible clinical and organizational practices [2]. To do so, nurses require new competencies to become eco-literate, eco-responsible, and eco-centric practitioners. Eco-literacy encompasses the knowledge, attitudes, and behaviours needed to sustain ecosystems and health, progressing from nominal to functional and operational levels of engagement [3,4]. Eco-responsibility refers to integrating environmental, social, and economic sustainability into professional practice through accountability, proactive action, and resilience [13]. Beyond this, adopting an eco-centric worldview enables nurses to transcend anthropocentric paradigms, recognise the interdependence of living systems, and embrace planetary stewardship as an ethical imperative [5–7].

As frontline healthcare workers and social actors, nurses play a crucial role in addressing climate-related health risks through global nursing. Global nursing is defined as the application of evidence-based nursing practices that advance planetary health and health equity across populations. It integrates the social determinants of health and encompasses care at both the individual and population levels through clinical practice, research, education, leadership, advocacy and policy engagement [8]. Although assessing nurses' environmental awareness is vital for advancing healthcare sustainability, evidence shows only moderate levels of knowledge, concern, and climate-related behaviours [6,9,10]. Studies also reveal limited understanding of healthcare's own contribution to climate change [11,12]. The CHANT survey confirmed moderate awareness (M = 2.97/4) but low levels of climate-related action in clinical practice (M = 1.81) despite high concern (M = 3.43) [13].

Previous studies have demonstrated that the CHANT is a valuable instrument for assessing nurses' environmental awareness related to climate change [14]. Beyond identifying current levels of climate-related competencies, the CHANT has also shown utility in highlighting educational needs, informing sustainability initiatives, supporting curriculum development, and evaluating interventions designed to strengthen environmental and planetary health competencies among healthcare professionals [15,16]. The CHANT, developed by Schenk et al. in 2019 [17] assesses nurses' awareness, motivation, concerns and self-reported behaviours related to climate change in both their professional and personal contexts. Although the CHANT was developed primarily as a measurement instrument, its conceptual basis is grounded in the Integrated Change (I-Change) Model. This model states that behavioural change results from interactions between awareness factors, motivational determinants, and behavioural processes. More specifically, attitudes, self-efficacy, and social influences are considered key determinants shaping motivation and behavioural intentions. Within this framework, environmentally sustainable behaviours require more than knowledge alone and involve multidimensional competencies integrating cognitive, emotional, and behavioural components. The CHANT operationalises these dimensions. Consequently, the instrument reflects a progression from climate-related knowledge and perceptions toward engagement in environmentally sustainable practices among healthcare professionals [13,15]. An exploratory factor analysis supported a five-factor structure, with a good model fit (CFI = 0.95; RMSEA = 0.04; SRMR = 0.09) and acceptable-to-high internal consistency across subscales (Cronbach's alpha ranged from 0.69–0.91). The CHANT questionnaire uses a five-point Likert scale [13,15]. Awareness is evaluated using five items that assess respondents' familiarity with the health impacts of climate change, with response options ranging from 1 ('I've never heard of it') to 5 ('I've definitely heard of it'). Concern is measured using five items that gauge respondents' degree of worry, rated from 1 ('Not at all') to 5 ('Extremely'). Motivation to act is assessed using three items, with responses ranging from 1 ('Never') to 5 ('Always'). Ecological behaviour is evaluated using two sets of items: five items for behaviours undertaken at home and four for behaviours at work, both rated on a scale from 1 ('Never') to 5 ('Always').

Despite its demonstrated utility and promising psychometric properties, the CHANT is not available in French. The absence of a validated French version constitutes a significant

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methodological and practical gap. This limitation restricts the assessment of eco-literacy and climate-related competencies among French-speaking healthcare professionals and hinders both international comparisons and the implementation of educational and clinical initiatives. Assessing content validity is a key step in the cultural adaptation of measurement tools for nursing research. Using both an item-level content validity index (I-CVI) and a scale-level content validity index (S-CVI) provides a rigorous method of ensuring item relevance and clarity. This is particularly important for tools like the CHANT, which target emerging concepts such as nurses' eco-literacy and require strong psychometric foundations to support their use in research, education and clinical practice. Therefore, the present study aimed to translate and culturally adapt the CHANT into French and to establish expert panel consensus on its item-level (I-CVI) and scale-level (S-CVI) content validity indices. A secondary objective was to examine potential associations between experts' sociodemographic and professional characteristics and their CVI assessments.

2. Materials and Methods

2.1. Design

To address our research objectives, we used a modified three-round, multicentre e-Delphi method guided by the Conducting and REporting DElphi Studies (CREDES) framework. As proposed by Jünger et al. [18] guarantees the rigour and transparency of this type of consensual approach [18]. The e-Delphi method [19] was selected for its methodological rigour, flexibility and capacity to facilitate anonymous, asynchronous expert input through an iterative process. Unlike traditional Delphi studies requiring strict panel stability, modified e-Delphi approaches may allow changes in panel composition when the primary objective is questionnaire development and content validation. In this context, maintaining diversity and relevant expertise may be prioritised over retaining identical participants across rounds. Accordingly, the present study aimed to iteratively refine the CHANT through multidisciplinary expert input rather than assess changes in individual opinions over time [20]. Finally, following completion of the 3 rounds, a cognitive debriefing session was conducted among the research team members and was not part of the online Delphi questionnaire. The purpose of this structured discussion was to review the final wording, semantic equivalence, comprehensibility, and cultural appropriateness of the translated CHANT items after integration of expert feedback from previous rounds [21]. This process aimed to ensure conceptual consistency and final agreement on the adapted instrument before its validation.

2.2. Translation and Linguistic Adaptation Procedure

The translation and cultural adaptation process followed internationally recognized recommendations for cross-cultural adaptation of self-report instruments [21,22]. First, a forward translation of the original English CHANT questionnaire into French was performed by two bilingual translators fluent in English and French and familiar with healthcare terminology. The two translated versions were subsequently compared and reconciled through discussion among the research team (OPDS and HV) to produce a single preliminary French version. Discrepancies related to wording, terminology, and conceptual interpretation were reviewed to ensure semantic and conceptual equivalence rather than literal translation. A backward translation into English was then performed by an independent bilingual translator who had no prior involvement in the study and was blinded to the original questionnaire. The back-translated version was compared with the original CHANT instrument to identify potential inconsistencies or conceptual deviations. Any discrepancies were resolved through a consensus-based discussion involving a third member of the research team. (FDH). Finally, linguistic validation was performed through iterative expert review during the modified e-Delphi process and a final structured review by the research team. This process focused on comprehensibility, semantic equivalence, cultural appropriateness, and conceptual consistency of the adapted French version.

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2.3. Data Collection

A modified online format was implemented using SurveyMonkey software, which enabled more streamlined administration. In contrast to traditional Delphi rounds, a real-time e-Delphi approach enables continuous expert interactions within defined timeframes using specialised software [10] (see Table 1).

Table 1. The multi-step modified e-Delphi survey procedure.

Round 1		
Questions asked about each item (12 items)		
We invite you to critically evaluate each item before rating it. Is this item comprehensible?	We invite you to critically evaluate each item before rating it. Is this item relevant? (Likert scale from 1–4).	**We also invite you to provide written comments to help us improve the relevance of the items in relation to the domain targeted. All feedback will be considered in subsequent rounds.**
1 = comprehensible 2 = partially comprehensible 3 = not at all comprehensible	1 = irrelevant 2 = somewhat relevant 3 = relevant 4 = highly relevant	Participants' suggestions were made in free text.
Experts could propose additional topics/items.		
Round 2		
Presentation of all the Round 1 items to ensure a comprehensive overview of the CHANT and to highlight the modifications made following Round 1's expert feedback and the consensus reached. **An additional item was included after Round 1 based on the experts' suggestions.**		
Items and response options	We invite you to critically evaluate each item before rating it. Is this item relevant? (Likert scale from 1–4).	**We also invite you to provide written comments to help us improve the relevance of the items in relation to the domain targeted. All feedback will be considered in subsequent rounds.**
1 = comprehensible 2 = partially comprehensible 3 = not at all comprehensible	1 = irrelevant 2 = somewhat relevant 3 = relevant 4 = highly relevant	Participants' suggestions were made in free text.
Experts could propose additional topics/items.		
Round 3		
The final questionnaire was submitted to the experts. No further comments were possible.		
Items and response options	We invite you to critically evaluate each item before rating it. Is this item relevant? (Likert scale from 1–4).	
1 = comprehensible 2 = partially comprehensible 3 = not at all comprehensible	1 = irrelevant 2 = somewhat relevant 3 = relevant 4 = highly relevant	
Round 4		
Cognitive debriefing		
1. The research team developed a final consensus on the item statements and response options after integrating all the comments from the international panel of experts.		

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2. Final linguistic review and consensus on semantic and cultural equivalence of the adapted French version.

2.4. Sample

Selecting the expert panel is a critical component of any Delphi study. As Sablatzky [23] highlighted, while representativeness is not required, participants must be engaged, knowledgeable and well-informed as their expertise and potential biases can substantially influence outcomes. Given the absence of universally accepted criteria for defining expertise in Delphi studies, expert selection was based on predefined eligibility criteria to ensure methodological credibility, confirmability, and consistency. Participants were recruited according to (1) their knowledge and/or professional experience in healthcare, sustainability, climate change, or planetary health; (2) their residence in French-speaking Switzerland, France or Belgium; and (3) their professional experience in the healthcare sector. This approach aimed to maximise the relevance and diversity of perspectives while ensuring consistency across study rounds [19,20]. French-speaking Switzerland, France, and Belgium were selected because, despite sharing a common language, they differ in healthcare organisation, educational structures, professional practices, and sociocultural perspectives that may influence the interpretation of climate-related concepts. Including experts from these contexts aimed to improve linguistic equivalence, cultural sensitivity, and the transferability of the adapted French CHANT version.

2.5. Statistical Analysis

Consensus in e-Delphi studies is typically defined by the percentage of participants endorsing an item, often supplemented by the proportion rating it highly on a Likert scale (e.g., scores of 4 or 5 on a five-point scale) [19]. An a priori consensus threshold is usually set, commonly ranging from 51% to 100%, with 75% agreement frequently used as the standard benchmark [24].

Data analysis was conducted using IBM SPSS Statistics software, version 29.0 (IBM Corp., Chicago, IL). Descriptive statistics summarised participants' sociodemographic and professional characteristics. Median and interquartile range (IQR) values were reported for quantitative variables (age and questionnaire completion time), and frequencies and percentages were reported for qualitative variables (sex, level of education, profession and country of residence). Content validity was assessed using item-level (I-CVI) and scale-level indices (S-CVI). Items were considered acceptable if their I-CVI was ≥ 0.78; those falling below this threshold were revised or removed according to expert feedback. S-CVI was computed using the average method (S-CVI/Ave), with an acceptability threshold of 0.90 or higher [40,41]. Although several methods exist for assessing content validity, including Lawshe's Content Validity Ratio (CVR), modified kappa coefficients, Aiken's V or Rasch-based indices, we selected I-CVI and S-CVI within a modified Delphi framework because our objective extended beyond determining item essentiality [25]. The iterative Delphi process allowed systematic refinement of translated items through repeated expert feedback and consensus building, which is particularly important in cross-cultural adaptation studies involving complex and emerging constructs such as eco-literacy and climate-related competencies [22]. Qualitative expert comments were also analysed, using open coding to refine unclear or insufficiently relevant items. Two authors independently performed a content analysis. Any discrepancies were resolved in consultation with a third author. Due to the limited sample size and the data's non-normal distribution (as verified using the Shapiro–Wilk test), we used non-parametric statistical methods. To evaluate potential associations between the expert panel's sociodemographic and professional characteristics and their assessments of the CHANT's I-CVI and S-CVI ratings, a Mann–Whitney U test was used for the sex variable and Kruskal–Wallis tests were used for educational level, profession and country of residence. Finally, Spearman's rank correlation coefficient was used to examine the relationships between age, questionnaire completion time, and the I-CVI and S-CVI scores. The level of statistical significance was set at $\alpha = 0.05$.

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3. Results

3.1. Sample Characteristics

A total of 233 individuals were invited to participate in the study. Overall, 117 participants (50.2%) initiated the questionnaire and 57 (24.5%) completed all items across the three Delphi rounds. Completion rates among participants who initiated the questionnaire were 80.6% (17/21) in Round 1, 88.2% (15/17) in Round 2, and 100% (25/25) in Round 3. Consistent with the modified e-Delphi design, participant characteristics were analysed separately for each round and represent round-specific respondents rather than longitudinal retention of identical participants. Most of the experts resided predominantly in Switzerland (55.0%), followed by France (43.3%) and Belgium (1.7%). The overall median age was 42 years old (IQR = 23), ranging from 20–74. Most participants were nurses (31.6%) and physicians (21.1%), with contributions from midwives, environmental specialists, allied health professionals, educators and university students. The variability observed across expert characteristics was intentional and reflected the multidisciplinary nature of the study topic. Given that climate change and sustainability involve clinical, educational, environmental, and public health dimensions, experts from different professional and educational backgrounds were included to maximise the diversity of perspectives while maintaining predefined eligible criteria (see Table 2).

Table 2. Sociodemographic and professional data on the panel of experts participating in the modified e-Delphi survey.

Sociodemographic variables	Round 1 experts (n = 17)	Round 2 experts (n = 15)	Round 3 experts (n = 25)
Country of residence, n (%)			
Switzerland	13 (76.5%)	13 (81.3%)	14 (56%)
France	2 (11.8%)	3 (18.8%)	10 (40%)
Belgium	2 (11.8%)	0 (0%)	1 (4%)
Sex, n (%)			
Male	7 (41.2%)	5 (31.3%)	7 (28%)
Female	10 (58.8%)	11 (68.7%)	18 (72%)
Profession			
Nurse	5 (29.4%)	6 (37.5%)	7 (28%)
Nursing student	0 (0%)	0 (0%)	1 (4%)
Midwife	0 (0%)	2 (12.5%)	0 (0%)
Physician	3 (17.6%)	3 (18.8%)	7 (28%)
Allied health professional	4 (23.5%)	0 (0)	1 (4%)
Health educator/clinical instructor	1 (5.9%)	1 (6.3%)	3 (12%)
Sustainability/environmental specialist	4 (23.5%)	3 (18.8%)	3 (12%)
Others	0 (0%)	1 (6.3%)	3 (12%)
Level of education, n (%)			
Bachelor's degree	4 (23.6%)	10 (62.5%)	6 (24%)
Master's degree	10 (58.2%)	3 (18.8%)	9 (36%)
PhD	2 (11.8%)	3 (18.8%)	6 (24%)
Continuing education (specialisation)	1 (5.9%)	0 (0%)	3 (12%)
Undergraduate	0 (0%)	0 (0%)	1 (4%)
Age [years], med (IQR)	40 (17.5)	43 (23)	42 (23)
Age [years], min–max	26–73	22–74	20–67
Questionnaire completion time [minutes], med (IQR)	21.9 (21.4)	25.47 (34.35)	10.6 (21.2)

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In Round 1 (n = 17), most participants were based in Switzerland (76.5%), with fewer from France and Belgium. The sample was predominantly female (58.8%), with a median age of 40 years old (range = 26–73 years; IQR = 17.5), indicating that the panel had broad professional experience. The median questionnaire completion time was 21.9 minutes (IQR = 21.4), excluding two extreme outliers (at > 1,440 minutes and > 10,080 minutes) attributed to asynchronous completion. Participants fulfilled a diverse range of healthcare and sustainability roles categorised into five groups for analysis: nurses, physicians, allied health professionals, health educators/clinical instructors and sustainability/environmental specialists. Nurses made up the largest group (29.4%), followed by sustainability and allied health professionals (23.5% each), physicians (17.6%), and educators (5.9%) (Table 2).

Round 2 participants primarily resided in Switzerland (81.3%), with a smaller number in France (18.8%) and none in Belgium. Most were female (68.7%). Regarding their professions, most were nurses (37.5%), followed by physicians (18.8%), midwives (12.5%), sustainability/environmental specialists (18.8%), and others (6.3%). Regarding their level of education, most held a master's degree (62.5%), followed by those with a PhD (18.8%) and those with a bachelor's degree (18.8%). No participants reported having a continuing education certificate or a bachelor's degree. The median age was 43 years old (range = 22–74; IQR = 23). The median questionnaire completion time was 25.47 minutes (IQR = 34.35) (Table 2).

Finally, in Round 3 (n = 25), most participants were from Switzerland (56%) and France (40%), with one participant from Belgium (4%). Median age was 42 years old (range = 20–67; IQR = 23). The median questionnaire completion time was 10.6 minutes (IQR = 21.2 minutes). One participant took over a week to complete the questionnaire, but this was considered an outlier and excluded, as in Round 1. Professions included nurses (28%), physicians (28%), educators (12%), sustainability specialists (12%), allied health professionals (4%) and one nursing student (4%). The 'other' category (12%) comprised a manager, an economist and a healthcare director. Among the nurses, two were identified as eco-nurses, healthcare professionals who have undergone a relevant continuing education course to understand and address the connections between environmental factors and human health. Their roles include raising awareness of environmental health risks (e.g., air pollution, endocrine disruptors), educating patients and peers on sustainable practices, promoting eco-responsible approaches in clinical settings and advocating for health policies that incorporate ecological concerns. Although the title of eco-nurse is not yet officially recognised in most French-speaking countries, specialised continuing education programmes are available in some regions. France's *Institut de Formation en Santé Environnementale* (IFSEN) offers a 189-hour hybrid training course on "Environmental Health: Theory and Practice", which covers key topics such as toxicology, ecology, sustainability and integrative health [26]. Some 36% of respondents held a master's degree, 28.0% had a bachelor's degree, 24.0% had a PhD, and 12.0% had completed specialised continuing education (Table 2).

This progression through the rounds reflects a shift from the professionally experienced, interdisciplinary expert panel in Round 1 to a more student-focused profile in Round 2, followed by a rebalanced, diverse panel in Round 3, aligning with the study's evolving goals.

3.2. Research Question Results

Following Round 1, the experts recommended adding a specific item, specifically concerning "Item 2: Concern." Consequently, round 1 comprised 12 items, whereas rounds 2 and 3 comprised 13 items.

In Round 1 (Figure 1), I-CVI ratings ranged from 0.79 (Item 4) to 1.0 (items 5, 6, 8, 9 and 12), indicating a generally strong agreement among the experts regarding item relevance. At 0.935, the average S-CVI (S-CVI/Ave) was high. In Round 2 (Figure 1), I-CVI ratings ranged from 0.71 (item 2) to 1.0 (items 3, 4, 5, 6, 8, 9 and 10), with Item 4 showing the most substantial improvement. In Round 3 (Figure 1), I-CVI ratings ranged from 0.823 (items 6 and 13) to 1.0 (items 1, 5 and 8–13). The S-CVI/Ave returned to 0.935.

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Across rounds 1 and 3 (Table 2), a 100% consensus was reached on key decisions. Consensus was not reached in Round 2 due to the I-CVI for Item 2 (0.71). While I-CVI ratings fluctuated for specific items—such as the notable increases for items 9 (0.93 *vs* 1.0 *vs* 1.0), 11 (0.85 *vs* 0.90 *vs* 1.0) and 12 (0.857 *vs* 0.941 *vs* 1.0), and the gradual decline for Item 7 (0.93 *vs* 0.90 *vs* 0.88)—overall content validity remained consistently strong. Items 5, 8 and 9 maintained an I-CVI of 1.0 in rounds 1 and 2 (Figure 1)

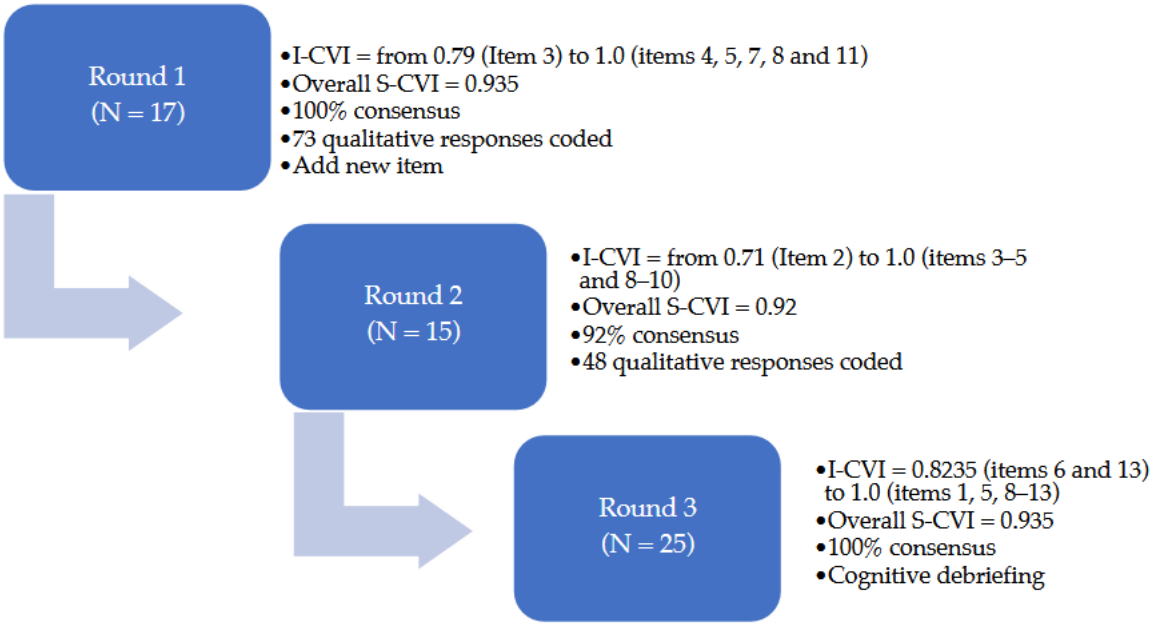

Figure 1. Reactive eDelphi process rounds and results.

Regarding item comprehension (Table 2), experts rated each item on a three-point scale: 1 ('Comprehensible'), 2 ('Somewhat comprehensible') and 3 ('Not comprehensible'). In Round 1, they unanimously rated items 1, 2 and 12 as comprehensible. However, some variability was noted for other items: one expert rated items 6, 7 and 8 as somewhat comprehensible, and two experts assigned this rating to item 11. Three experts also rated items 3 and 10 as somewhat comprehensible, while item 4 received that rating from four experts. Notably, the same expert rated items 5, 7, 8 and 9 as not comprehensible (rating 3) and suggested corresponding reformulations. In Round 2, all the experts rated items 1, 3, 4, 6, 8, 9, 10 and 13 as comprehensible. Despite this consensus, some dissent remained. Only item 2 was rated three by one expert. Item 11 was rated two by two experts, and items 2, 5, 7 and 12 were rated two by one expert.

To assess the items' relevance, the experts used a Likert scale ranging from 1–4: 1 ('Irrelevant'), 2 ('Slightly relevant'), 3 ('Relevant') and 4 ('Highly relevant') (see). In Round 1, item 5 received the highest mean rating of 3.79 and the most favourable evaluation in the set. Conversely, items 3 and 12 had the lowest mean ratings, both at 3.07. The severity of expert ratings was further analysed by examining the frequency of low ratings (1 or 2) assigned to items. Expert 1 was strict, assigning a rating of 1 to item 6, signifying that they judged it 'Irrelevant'. Experts 3 and 9 exhibited greater overall stringency, each assigning ratings of 2 to three distinct items. Expert 13 also showed moderate severity, with two items rated at 2. This analysis highlighted variations in experts' stringency during the relevance evaluation process. In Round 2, items 3, 4, 5, 9 and 11 received the highest mean rating (M = 3.67), whereas Item 1 obtained a mean rating of 3.11. Item 2, which was suggested by the panel during Round 1, received a mean comprehension rating of 3.33. In Round 3, Item 10 achieved the highest mean rating (M = 3.78) and Item 2 received the lowest (M = 3.00). The most severe evaluators were Expert 3 (who assigned one rating of 1 and one of 2), Expert 2 (who assigned three ratings of 2) and Expert 15 (who assigned two ratings of 2).

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Table 3. I-CVI and relevance across the three rounds.

	Round 1 I-CVI	Mean Relevance		Round 2 I-CVI	Mean Relevance	Round 3 I-CVI	Mean Relevance
Item 1	0.93	3.53	**Item 1**	0.91	3.11	0.91	3.5
---	**---**	**---**	**Item 2**	0.71	3.33	0.84	3
Item 2	0.93	3.13	**Item 3**	1	3.67	0.89	3.3
Item 3	0.79	3.07	**Item 4**	1	3.67	0.89	3.3
Item 4	1	3.43	**Item 5**	1	3.67	1	3.67
Item 5	1	3.79	**Item 6**	0.80	3.22	0.82	3.56
Item 6	0.93	3.31	**Item 7**	0.90	3.22	0.88	3.67
Item 7	1	3.64	**Item 8**	1	3.44	1	3.44
Item 8	1	3.38	**Item 9**	1	3.67	1	3.63
Item 9	0.93	3.36	**Item 10**	1	3.56	1	3.78
Item 10	0.86	3.14	**Item 11**	0.90	3.67	1	3.56
Item 11	1	3.36	**Item 12**	0.90	3.44	1	3.56
Item 12	0.86	3.07	**Item 13**	0.90	3.22	0.82	3.22

During each round, experts were also invited to suggest item statement reformulations. These suggestions primarily involved terminological clarifications, the addition of response options or the refinement of ambiguous wording, either by providing explanations or by replacing specific terms. Each proposed modification was submitted for validation in the subsequent round. Table 4 presents the items for which the expert panel suggested reformulations.

Table 4. Comprehension across the three rounds.

	Round 1				Round 2			Round 3		
	1	**2**	**3**		**1**	**2**	**3**	**1**	**2**	**3**
Item 1	100%	0%	0%	**Item 1**	100%	0%	0%	90%	10%	0%
---				**Item 2**	90%	10%	0%	100%	0%	0%
Item 2	78.6%	21.4%	0%	**Item 3**	100%	0%	0%	95%	5%	0%
Item 3	78.6%	21.4%	0%	**Item 4**	100%	0%	0%	68.4%	31.6%	0%
Item 4	71.4%	28.6%	0%	**Item 5**	90%	10%	0%	84.2%	15.8%	0%
Item 5	92.9%	0%	7.1%	**Item 6**	100%	0%	0%	81.3%	18.7%	0%
Item 6	92.9%	7.1%	0%	**Item 7**	80%	0%	20%	94.4%	5.6%	0%
Item 7	85.7%	7.1%	7.1%	**Item 8**	100%	0%	0%	82.4%	17.6%	0%
Item 8	85.7%	7.1%	7.1%	**Item 9**	100%	0%	0%	93.8%	6.2%	0%
Item 9	71.4%	21.4%	7.1%	**Item 10**	100%	0%	0%	100%	0%	0%
Item 10	78.6%	21.4%	0%	**Item 11**	90%	10%	0%	94.8%	5.2%	0%
Item 11	85.7%	14.3%	0%	**Item 12**	90%	10%	0%	94.1%	5.9%	0%
Item 12	92.9%	7.1%	0%	**Item 13**	100%	0%	0%	94.4%	5.6%	0%

For comprehension, the number of ratings at 1, 2 or 3 is shown as a percentage.

In Round 1, Item received the most suggestions, with seven experts proposing different rewordings to make it easier to understand. One expert proposed adding the concept of "risks linked to increased pollution and the future issue of climate refugees." Another proposed a definition relating to intergenerational climate injustice. Item 2 received the fewest proposals for change. One expert proposed adding a definition of the concept of One Health, and two experts added a proposed response, specifically the concept of being "climate sceptical."

In Round 2, only Item 4 received more proposed changes than in Round 1 (three experts suggested rewording and three suggested additions, compared to two rewording suggestions and three additions in Round 1). Item 11, remained unchanged, with eight proposed rewordings or additions. Item 11 received the most suggested changes, with six experts suggesting rewording to

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improve comprehension or simplify the item's wording. Two experts suggested additions, in particular, clarifications to the various response options. Conversely, Item 13 received the fewest suggestions for change, with only one expert proposing rewording so that one response choice could be split into two. Suggested modifications and additions from previous rounds were integrated and subsequently presented to experts during Round 3 for further evaluation and consensus.

In conclusion, from Round 1 to Round 2, experts proposed terminological refinements—most notably replacing 'climate change' with 'climate disruption'—to increase the semantic precision of the items. Item content was further enriched by the integration of underexplored issues such as biodiversity loss, climate-related migration and gender-based inequalities. Simultaneously, variables related to experience and motivation were expanded to capture greater nuance, and experts advocated for a shift from an individualistic framing of climate action towards a more collective and systemic perspective. Between Round 2 and Round 3, the focus moved toward strengthening the CHANT's scientific rigour. Experts recommended incorporating references to authoritative sources (e.g., The Lancet, the OECD) and refining key definitions to bolster conceptual robustness. Structural determinants, such as social inequalities, public policy and broader societal impacts, became increasingly emphasised. The emotional dimension remained a key focus, with the inclusion of more open-ended items to capture the complexity of affect. Lastly, the tool was further contextualised for the healthcare sector, with greater attention given to clinical practices, their environmental implications and the adaptive responses required within care delivery.

Table 5. Experts' comments and suggestions.

Item	Round	Re (n)	Add (n)	Experts' suggestions
1	1	2	7	Addition of concepts and definitions
1	2	2	4	Clarification of gender-related impacts; additional response option; scientific reference
2	1	0	3	Addition of One Health definition and response options
2	2	2	0	Minor wording refinements
3	1	6	3	Clarification of climate/weather distinction; addition of "landslide" and "heatwave" concepts
3	2	2	1	Addition of a new concept
4	1	2	3	Definition refinement; conceptual clarification; illustrative example
4	2	3	0	Further wording simplification
5	1	4	3	Addition and revision of concepts
5	2	3	3	Additional concepts and response options
6	1	4	1	Item wording modification
6	2	3	0	Simplification of item and response wording
7	1	4	2	Additional response options
7	2	3	0	Minor wording modifications
8	1	5	0	Minor wording refinements
8	2	3	2	Additional response options
9	1	6	0	Wording refinements
9	2	1	2	Addition of concepts
10	1	6	2	Additional concepts
10	2	2	0	Minor wording refinements
11	1	4	2	Additional response options
11	2	6	2	Clarification of response categories
12	1	2	2	Addition of concepts
12	2	2	1	Additional concept
13	2	1	0	Splitting of a response category
Total		78	43	

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Re = reformulation; Add = addition of a term, definition, concept or other.

Following completion of the Delphi rounds, the research team conducted a cognitive debriefing session to review the final wording and ensure semantic consistency and comprehensibility of the adapted instrument.. The study team validated the final version and agreed on the CHANT's overall rating (S-CVI) (see Table 1).

The Mann–Whitney U test was used to compare comprehension and relevance ratings according to participants' sex. No statistically significant sex-related differences were identified across the three Delphi rounds. In Round 1 (n = 17), comprehension ratings ranged from U = 15.00–27.00 (p = 0.282–1.000), whereas relevance ratings ranged from U = 22.00–39.00 (p = 0.108–1.000). Similarly, no significant differences were identified in Round 2 (n = 15; comprehension: p = 0.200–1.000; relevance: p = 0.200–0.973) and Round 3 (n = 25; comprehension: p = 0.350–1.000; relevance: p = 0.130–0.878). Overall, these findings indicate comparable distributions of comprehension and relevance ratings between male and female participants despite the predominance of female participants in the expert panel.

The Kruskal–Wallis test was used to compare ratings according to experts' educational level, profession and country of residence. In Round 1, statistically significant differences were found for the relevance of Item 6 by educational level (PhD, master's, bachelor's, specialisation, or undergraduate) ($H(2) = 9.65$, $p = 0.008$, $\varepsilon^2 = 0.55$) and for the comprehension of Item 6 by country of residence (Swiss, French, Belgian), ($H(2) = 6.106$, $p = 0.047$, ε^2=0.29) with a large effect size. In Round 2, significant associations were found between the comprehension of items 11 and 12 and expert nationality indicating a large effect size ($H(1) = 9.00$, $p = 0.003$, ε^2=0.62, for both items). Item 11's relevance also varied by nationality ($H(1) = 5.00$, $p = 0.025$, $\varepsilon^2 = 0.31$). Finally, in Round 3, the distribution of comprehension ratings for Item 5 varied by expert nationality ($H(3) = 9.031$, $p = 0.029$, $\varepsilon^2 = 0.29$), indicating a significant perceived difference. Item 11's relevance varied according to the expert's profession (nurse, physician, allied health professional, health educator/clinical instructor, or sustainability/environmental specialist) ($H(7) = 16.00$, $p = 0.025$, $\varepsilon^2 = 0.53$). The significant associations observed between expert characteristics and item ratings suggest that perceptions of climate-related concepts may be influenced by professional experience, sociocultural context, and individual backgrounds. Differences according to profession may reflect varying levels of exposure to sustainability concepts and different professional priorities within healthcare practice. For example, experts with educational or environmental backgrounds may be more familiar with climate-related terminology than clinicians primarily focused on patient care activities. Similarly, differences associated with country of residence may reflect contextual variations in healthcare systems, educational curricula, public policies, and societal awareness of climate-related issues. Although Switzerland, France, and Belgium share a common language, they differ in their approaches to sustainability and environmental health, which may influence the interpretation of specific concepts.

Spearman's rank correlations were performed to examine relationships between item comprehension and relevance ratings, as well as participants' age and questionnaire completion time. In Round 1, a significant positive correlation was identified between age and comprehension of Item 8 ($r_s = 0.55$, $p = 0.041$), suggesting that older participants perceived this item as less comprehensible. No significant associations were observed between age and the comprehension of the remaining items. Likewise, no meaningful association was found for Item 11 comprehension ($r_s < 0.001$, $p = 1.000$), indicating a negligible relationship. Regarding item relevance, a significant negative correlation was observed between Item 10 and questionnaire completion time ($r_s = -0.73$, $p = 0.007$), indicating that experts who rated this item as more relevant tended to complete the questionnaire more rapidly. In Round 2, a significant positive correlation emerged between the perceived relevance of Item 13 and completion time ($r_s = 0.64$, $p = 0.047$), suggesting that this item may have required greater reflection or cognitive processing. A significant negative association was also observed between age and the perceived relevance of Item 10 ($r_s = -0.66$, $p = 0.037$), indicating that older experts

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tended to assign lower relevance ratings. In Round 3, a strong positive correlation was found between questionnaire completion time and comprehension of Item 12 ($r_s = 0.75$, $p < 0.001$), suggesting that participants who required more time to complete the questionnaire may have engaged in more detailed consideration of this item. These findings suggest that expert perceptions may vary according to individual and professional characteristics, potentially reflecting differences in experience, educational exposure, and familiarity with sustainability and planetary health concepts. Collectively, these results support the importance of incorporating multidisciplinary and cross-cultural perspectives during questionnaire adaptation processes to enhance semantic relevance, cultural sensitivity, and broader applicability.

4. Discussion

Our modified e-Delphi survey to culturally adapt and validate the French version of the CHANT showed progressive improvement across three rounds, with overall S-CVI increasing and several items (e.g., 10, 11, 13) reaching perfect I-CVI scores by the final round. Iterative feedback enhanced comprehension—most notably for Item 10—while items such as 6 and 1 revealed fluctuations suggesting potential wording or conceptual issues. Item 11 consistently demonstrated high relevance but varied by country of residence, underscoring cultural and contextual influences. As expected, qualitative suggestions decreased across rounds, reflecting greater conceptual clarity and convergence of expert opinion.

Sociodemographic analyses revealed differences by education, profession, and country of residence, again with Item 11 emerging as context sensitive. Correlations between age, response time, and ratings suggested that complexity influenced engagement. These findings highlight the importance of tailoring tools to local sociocultural and healthcare contexts to maximise validity. The diverse, international, and interprofessional panel—including nurses, physicians, allied health professionals, educators, and sustainability experts from Switzerland, France, and Belgium—strengthened the tool's content validity by ensuring multiple perspectives. Overall, this process enhanced the robustness of the French CHANT as a valid interprofessional instrument for clinical practice and research in healthcare.

4.1. Implication for Practice

Assessing nurses' eco-literacy is a critical step for designing evidence-based educational strategies that strengthen environmental competencies in healthcare. Embedding nursing practice within an eco-responsible framework requires integrating environmental considerations into clinical decision-making while safeguarding quality and safety. Educational interventions must therefore be efficient, tailored, and contextually relevant to foster proactive and ethically grounded action. A systematic review by Portela Dos Santos et al. [27] identified three main types of interventions for enhancing evidence-based practice competencies: multifaceted strategies with mentoring, single-component approaches (often online), and structured programmes based on the five EBP steps. Similarly, recent studies have shown the effectiveness of web-based, video-based, and virtual educational programmes in improving nurses' climate awareness, activism, and pro-environmental behaviours [28–30]. Tools such as the CHANT can further support the integration of environmental imperatives into safe, patient-centred nursing practice.

4.2. Implications for Education

Systematically integrating sustainability, planetary health and eco-literacy into nursing education curricula is imperative at all levels—undergraduate, postgraduate and continuing professional development. The present study suggests that the CHANT may serve as a useful tool for identifying educational needs related to climate change and sustainability among nurses and nursing students. Such information could support the design and evaluation of targeted educational interventions and inform future curriculum development.

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4.3. Implications for Research

Variations in the comprehension and relevance of certain CHANT items, particularly Item 11, underscored the need to account for cultural and contextual factors when developing assessment tools. This aligns with implementation science principles, which stress adapting instruments to local healthcare systems, educational models, and environmental priorities to ensure validity and acceptability [31–33]. Iterative adaptation with stakeholder involvement is therefore essential to maintain relevance, engagement, and clarity, ultimately supporting culturally sensitive and eco-centric health leadership. The CFIR framework offers a structured approach to guide this process across pre-, peri-, and post-implementation phases [31–33]. [34]Finally, the addition of a new item based on experts' recommendations may influence the psychometric properties and comparability of the adapted CHANT with the original version. Although this modification aimed to improve content relevance and contextual adaptation, further psychometric validation is required. A subsequent study will therefore evaluate the factorial structure, construct validity, internal consistency, and reliability of the adapted French CHANT.

4.4. Strengths and Limitations

Situating the CHANT within the I-Change Model strengthens the theoretical interpretation of its dimensions and findings. Variations observed across awareness, concern, motivation, and ecological behaviour may reflect differences in motivational processes and contextual influences operating across healthcare systems and cultural environments. Understanding these relationships may facilitate the design of future educational and implementation interventions aimed at strengthening nurses' eco-literacy and sustainability-related competencies. The use of a modified e-Delphi survey proved advantageous, as technology facilitated broader panel participation (n = 57) and reduced study duration, while maintaining anonymity to encourage creativity and balanced input. The multidisciplinary panel—comprising nurses, physicians, allied health professionals, educators, and sustainability experts from Switzerland, France, and Belgium—contributed to improving item comprehensibility, relevance, and cultural appropriateness, thereby strengthening the content validity of the adapted instrument [35,36]. Furthermore, iterative rounds combining qualitative and quantitative feedback facilitated progressive refinement of the questionnaire and promoted interprofessional collaboration.

Nevertheless, several methodological limitations should be acknowledged. The use of different experts across rounds may be considered a methodological limitation because traditional Delphi studies generally recommend maintaining a stable panel throughout the process. However, our modified e-Delphi approach focused primarily on iterative content validation rather than on measuring opinion evolution over time. Recruiting experts using identical eligibility criteria and preserving multidisciplinary diversity aimed to maintain consistency in expertise across rounds. Then, reliance on expert opinion may have restricted internal validity, as consensus does not guarantee item comprehensiveness [37,38]. The choice of a Delphi-based CVI approach was motivated by its ability to combine quantitative agreement indices with qualitative expert feedback during iterative adaptation cycles. Although alternative methods such as CVR or chance-adjusted agreement statistics could have been used, they would not have provided the same opportunity for progressive item refinement and contextual adaptation. Also, the Delphi method was not designed to test associations between participant characteristics and ratings, and consensus thresholds (I-CVI, S-CVI) remain non-standardised, limiting comparability. In addition, potential professional connections between participants and restriction to French-speaking experts may reduce independence and transferability of findings.

5. Conclusions

Knowing and improving the French-language version of the Climate, Health, and Nursing Tool's (CHANT) internal content validity will prove essential to ensuring its overall validity and

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reliability: It will thus measure what we want it to measure. Our modified e-Delphi survey used a rigorous methodology to establish consensus and calculate the tool's content validity index. At the end of the e-Delphi process, a consensus had been reached on the CHANT's item-level content validity index (I-CVI) ratings and its scale-level content validity index (S-CVI) rating. We concluded that the CHANT possessed all the necessary internal content validity properties and that it should subsequently undergo further pilot clinical testing to assess its reliability and validity using interprofessional samples of appropriate patient groups. Validating the CHANT both conceptually and psychometrically is a critical step toward developing and strengthening nurses' competencies in planetary health. While education about sustainability has shown promise in improving students' knowledge and behaviours, integrating content on climate change into nursing curricula remains a challenge. To design effective future educational interventions, it is essential to align them with healthcare professionals' specific needs, beginning with a clear assessment of their current level of eco-literacy.

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