Cross-cultural adaptation of children´s environmental health questionnaires for English nursing students

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Abstract

Objectives: Children are the most vulnerable population group with regard to environmental risks. Nursing students must be fully educated in children's environmental health as they are in a key position to prevent and reduce the effects of environmental hazards. The main objective of this study was to adapt and validate an English version of two questionnaires about children's health and the environment to assess the knowledge and skills of English student nurses.
Design: Observational cross-sectional study.
Setting: An English university.
Method: To translate, adapt and validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) for English nursing students (*N* = 232). Subsequently, descriptive values were calculated with the data collected from English nursing students.
Results: The psychometric characteristics found in both questionnaires were strong. Infit and outfit values were near one. The reliability values for the items and people were 0.96 and 0.79 for ChEHK-Q and 0.98 and 0.89 for ChEHS-Q. Only 52 (22.41%) and 77 (33.62%) participants had at least good knowledge and skills, respectively. Higher knowledge and skills were found with respect to the vulnerability of children and identification of environmental risks in the home, respectively. Lower levels of knowledge and skills were found with respect to the effects of pesticides and assessment of neoplastic pollutants, respectively.
Conclusion: Findings demonstrate deficiencies in competencies related to children's environmental health. These questionnaires will facilitate improvement in both the knowledge and skills related to children´s environmental health among future nurses.

Keywords: child health, environmental health, nursing students, questionnaire, university

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Introduction

In recent years scientific evidence has shown that climate change is a health problem of vast dimension (Landrigan et al., 2019; Sullivan-Marx and McCauley, 2017). Children are the most vulnerable group in relation to exposure to environmental risk factors because of their physical immaturity and psychosocial dependence. They are also at risk due to their need for positive stimuli and their extra communication needs. More than two thirds of children are threatened by environmental risks in their own homes where they learn and play (McBridge, 2016). The World Health Organisation (WHO) estimates that approximately one third of the disease burden in developing countries is attributable to modifiable environmental factors, including indoor and outdoor air pollution, unsafe water, inadequate sanitation and hygiene (Etzel, 2015).

Health professionals have an important role to play in understanding and communicating that issues related to environmental risks are a major threat (McBridge, 2016). The International Council of Nursing's Declaration on Sustainable Development Goals in 2018 stressed the importance of nurses having a comprehensive education in children's environmental health. This should enable nurses to respond to children at the different stages of growth and development to prevent and alleviate environmental hazards relevant at key developmental stages. In order to gain the essential knowledge and skills in this area, it is necessary to start training nurses on these issues in universities. In contrast to this ideal, evidence suggests that education on environmental aspects in the nursing curriculum is somewhat limited (McDermott-Levy et al., 2019).

Identified child health competency deficits will require nurse educators to take a strong lead in ensuring that future nurses are prepared to identify, prevent and treat environmental child health issues. This places nurse education in a key position to equip nurses with the knowledge and skills to pioneer innovative and creative responses to improving environmental child health (McDermott-Levy et al., 2019; Torres-Alzate et al., 2019; Walpole et al., 2019). Similarly, nurses need relevant knowledge and skills in order to promote children´s environmental health (Álvarez-Nieto et al., 2017; Gellar, 2015; López-Medina et al., 2019).

This education should address environmental impacts and the need for effective health promotion. Additional key aspects include nutrition, smoking, the effects of passive smoking and environmental issues around food production (López-Medina et al., 2019). It should also encompass the interaction of the environment and child health at different levels (Álvarez-Nieto et al., 2017).

Nurses must develop competent communication skills in order to undertake health promotion, environmental health counselling and education for children and families. It is important that nurses develop the ability to reflect and act upon on environmental risks and related interventions that must be developed from a holistic and ethical perspective (Álvarez-Nieto et al., 2017; López-Medina et al., 2019).

Nurses are in a unique position to promote health as a key part of their role (López-Medina et al., 2019) but in order to achieve this, it is necessary to have accurate knowledge and skills with respect to children´s environmental health. Assessing this knowledge and skills can be undertaken using questionnaires that are reliable and valid. Recommendations can then be made in relation to the educational

measures needed to ensure that future nurses will be able to prevent, detect and eliminate environmental risks from children´s lives (Richardson et al., 2014).

Felicilda-Reynaldo et al. (2018) conducted a multi-Arab country study of nursing students focusing on the knowledge, attitudes and perceptions of the health impacts of climate change and the role of nursing in addressing them. Findings revealed only a moderate knowledge of environmental health. Factors affecting this included the student's country of residence, type of community and academic year. Nigatu et al. (2014) used a questionnaire with Ethiopian health science students to assess their knowledge of the health impacts of climate change. Over three quarters of the students were aware of the health consequences of climate change. A Spanish study by Álvarez-García et al. (2018) assessed students´ knowledge and skills related to children´s environmental health using the Children´s Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children´s Environmental Health Skills Questionnaire (ChEHS-Q). Concerningly they identified a substantial number of students whose knowledge and skills were not adequate in this important area.

Good quality scales and/or questionnaires should demonstrate psychometric properties of consistency in both reliability and validity (Polit and Beck, 2008 Only two of the knowledge questionnaires used had been validated in the Arab-state (Felicilda-Reynaldo et al., 2018) and Spanish (Álvarez-García et al., 2018) contexts. The ChEHK-Q was developed and validated to determine specific knowledge of environmental pollutants and their effects on children's health, and in relation to skills, the ChEHS-Q specifically assesses skills to manage environmental risks in nursing (Álvarez-García et al., 2018); neither of these questionnaires, however, has been validated among English-speaking students in an English context.

There appears to be an absence of adequate English tools to determine the competencies of nursing students in relation to the major environmental issues affecting children's health. The first objective of this study, therefore, was to translate, adapt and validate an English version of the ChEHK-Q and ChEHS-Q scales that had previously been developed and tested with students in Spain. These were then tested on a cohort of English student nurses studying for a BSc in child health nursing. The second objective was to assess the knowledge and skills related to environmental health issues relevant to children among nursing students in Southern England.

Materials and methods

The design was an observational cross-sectional study to translate, adapt and validate the ChEHK-Q and the ChEHS-Q**Error! Bookmark not defined.** (Álvarez-García et al., 2018) for nursing students in England.

- ChEHK-Q is composed of 26 items, with *true*, *false*, and *I do not know* answer options, with a maximum score of 26 points. The score range varies from *excellent knowledge* (> 90% correct answers) through *very good knowledge* (80–89%), *good knowledge* (60–79%) and *insufficient knowledge* (40–59%), to *poor knowledge* (< 39%).
- ChEHS-Q is composed of 12 items, for which the response options range from one to five on a Likert scale, with a maximum score of 60 points. Items two, four, six, eight, 11 and 12 are reverse-scored. The score range varies from

excellent skills (> 90% perceived skills) through *very good skills* (80–89%), *good skills* (70–79%) and *insufficient skills* (50–69%) to *poor skills* (< 49%).

International Test Commission (2017) guidelines were followed in translating, adapting and validating the questionnaires. As the original versions of the ChEHK-Q and the ChEHS-Q were designed as a 26-item questionnaire and a 12-item questionnaire respectively, both are available online or on paper and can be self-administered. Scores can be calculated by adding up the number of correct answers on the ChEHK-Q or by adding up the scores obtained on the Likert scale for the ChEHS-Q. The questionnaires are available through the website of the project that developed them (Nursing and Innovation in Healthcare, 2018).

This process of translation, adaptation and validation consisted of two phases:

Phase 1: Translation and adaptation process

First, the questionnaires were translated into English using a centred or asymmetric method (Polit and Beck, 2008) to ensure that all the items of the questionnaires were translated without changing their meaning, adding new items or eliminating any of the items. This method was used because the questionnaires had been used in a previous study (Álvarez-García et al., 2018) with the same objectives as the current investigation. There were distinctive and desirable features which needed to be consistent.

In order to achieve semantic equivalence (Polit and Beck, 2008), translation was undertaken by two bilingual English natives; a lecturer in child health nursing and a student nurse. Following this, the authors of this study and the translators discussed any disagreements to reach a consensus which produced a single version (synthesis) from both translations. This was followed by a back-translation (the translated items were translated into Spanish again) by two bilingual Spanish natives, two lecturers with experience in translation, and finally a committee was formed with the translators and the authors. From this, a matrix was built to visualise the original item, the translated item and the two back-translated items (Supplementary material 1 and 2). Minor discrepancies between them were found, and these were adjusted to ensure that the meaning of the English items was equivalent to the meaning of the Spanish items. All those involved in this process were given information about the key constructs, the aim of the questionnaires and the target population to enhance consistency.

It was important to achieve conceptual equivalence as suggested by Polit and Beck (2008) so as to ensure that the concepts of children´s environmental health knowledge and children´s environmental skills were understandable in the target culture. Two of the lecturers undertaking the research at the university in England were asked to amend the English grammar and syntax. This was appropriate as they were familiar with the target culture.

Phase 2: Validation process

A sample size of at least 222 was needed, following the recommendations for the validation of questionnaires proposed by Streiner and Kottner (2014) and in order to

get an 80% of statistical power based on the previous study carried out by Álvarez-García et al. (2018). The sample was therefore comprised of 232 undergraduate nursing students registered in the first, second and third years of a BSc programme in child health nursing (Table 1). The questionnaires were sent by email to the students, who completed them individually rather than in groups or pairs, using Survey Monkey. Data collection took place between May and September 2018. Students who completed the questionnaire inadequately or incompletely were excluded. The response rate was 88%.

[Insert Table 1 about here]

A psychometric analysis of the questionnaires was carried out using a parameter model based on item response theory, which itself is based on three assumptions (Navas, 1994). Firstly, the one-dimensionality of the questionnaires was checked through an exploratory factor analysis (EFA) of each one. Both questionnaires were one-dimensional as in the original Spanish versions. Secondly, local independence was checked using Yen's Q3 statistic; the item correlation ranged from -0.25 to 0.24 for ChEHK-Q and from -0.35 to 0.41 for ChEHS-Q (these values are near to the recommended values ± 0.2) (Meyer, 2014). Thirdly, the parameters of subjects (θ) and items (β) were analysed for the variables of knowledge and skills, which were shown on an item map. Infit and outfit statistics were used to fit the data to the model (optimal fit values ranged from 0.7 to 1.3) (Prieto and Delgado, 2003).

The ChEHK-Q was analysed using the Rasch model. This calculated the difficulty of the items with 0 being the mean level of difficulty; this statistic classified the item with the highest score as the easiest and the item with the lowest score as the most difficult. The model also considered that the separation index and separation values should ideally be larger than 2 (Meyer, 2014). An internal consistency value of 0.70 or higher (Nunnally and Bernstein, 1995) was considered acceptable for the reliability analysis; these values were calculated for items and subjects.

The ChEHS-Q was analysed using Andrich's rating scale model which is based on similar assumptions and parameters as the Rasch model. In addition to item (mis)fit, this model analysed threshold ordering by inspecting estimated threshold locations along the latent trait, skills in children´s environmental health, because the disorder of thresholds may indicate the inappropriate functioning of response categories. These analyses were performed with jMetrik software using a joint maximum likelihood method.

Descriptive analysis

The total addition of the number of items with correct answers was used to calculate the knowledge score, and the total addition of the points on the Likert scales was used to calculate the skills score. So, the descriptive values of the questionnaire scores were: correct answers and ignorance index for knowledge items and means for skills items. The number of participants with excellent, very good, good, insufficient or poor knowledge and skills were calculated following the instruments guidelines (Álvarez-García et al., 2018). The relationship between knowledge and attitudes was determined by Pearson's correlation coefficient. The rule of thumb (Mukaka, 2012)

was used for interpreting the size of the correlation coefficient. Tests of differences of means were also used to compare the questionnaire scores according to gender, year of course and attendance at sessions on sustainability and nursing to detect statistically significant differences between scores. The normal data distribution was tested with the Kolmogorov-Smirnov test. A value of $p < 0.05$ was estimated to be significant. Data were entered into SPSS version 24 for analysis.

Ethics

This study was approved by the institutional review board of a large university in England. An information sheet was developed for the participants, and if they wanted to proceed, they had to sign a written consent form. We followed the university policy on safe storage, transportation, access and use of data. Students were not obliged to fill out the questionnaires, and it did not affect their grade for any course. The confidentiality of personal data that could identify participants was guaranteed.

Results

Children's Environmental Health Knowledge Questionnaire

In the Rasch model, the items show central values at 1 for infit and outfit (Table 2). In order to check the correct item functioning, θ and β were represented on an item map (Figure 1). Most of the items were in the central area where the greatest load of student ability was represented, although there were some items in the high and the low part of the student density to classify participants with high and low knowledge, respectively. Item five “Nitrogen oxide from fossil fuels in the home and tobacco smoke causes redness and burns on the skin” surpassed the set outfit value, 1.83, but its infit value was adequate and was functioning correctly in the item map. The global mean for the infit was 0.995 (0.857 to 1.156), and the global mean for the outfit was 0.997 (0.749 to 1.837); these values are in the average of the setting values for infit and outfit. The difficulty values ranged from -1.48 to 1.67, ranging from negative to positive values, so that in this broad spectrum students could be properly classified according to their knowledge. The item separation index was 4.96 and the student separation index was 1.99; so, the sufficiency of the items in order to classify the students according to their knowledge was shown. The reliability value for the items was 0.96 and for the students was 0.79. These values show the strength of the items to adequately rank order students on the latent trait.

[Insert Figure 1 & 2 and Tables 2 & 3 about here]

Children's Environmental Health Skills Questionnaire

In the ChEHS-Q Andrich's rating scale model (Table 3), item three, “I am able to identify the environmental risks that can cause neoplastic diseases in a child”, slightly overfit (1.32 for infit and 1.31 for outfit) as did item four, “I am NOT able to identify the environmental risks that can cause neurological disorders in a child” (1.31 for infit

and outfit). In order to assess the items' functioning, they are shown on the item map (Figure 2). Most of the items are located in the region with the most examinations; only item three is slightly higher than student ability, but it is useful to classify students with higher abilities than these in this study since any participant in this sample had a perfect ability to manage children´s environmental health problems. Mean infit value was 0.996 (0.723 to 1.313), and mean outfit value was 1.001 (0.712 to 1.302). Difficulty values range from -0.85 to 1.51, ranging from negative to positive values, so that students could be properly classified according to their skills. The item separation index was 6.98, and the student separation index was 2.85. The item separation was strong since the values surpass 2, thus showing that the number of items was sufficient to classify the students according to their skills. The reliability for the set of items was 0.98, and for students it was 0.89, being suitable in both cases. The values identified demonstrate the strength of the items to adequately rank order students on the latent trait as well.

Table 4 demonstrates that the thresholds on the ChEHS-Q Likert scale range from a low of -2.00 to a high of 2.63, increasing their value progressively on the scale; there were no reversals. This would suggest that the Likert scale was working correctly with five response options.

[Insert Table 4 about here]

Descriptive analysis

For the ChEHK-Q, the mean score was 11.59 ± 5.09. Item one, "The pediatric population is more susceptible to environmental threats due to their biological immaturity", was the item that had the highest percentage of correct answers (72.8%), while item nineteen, "The major source of childhood exposure to pesticides is through ambient air", had the lowest (15.1%). The most unknown item was 18, "Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic", with an ignorance index of 68.50%. For the ChEHS-Q, the average score was 38.36 ± 7.86. Item eight, "I am able to identify the environmental risks in a child's home", was the item with the highest perceived skills (3.73 ± 0.90), and item three, "I am able to identify the environmental risks that can cause neoplastic diseases in a child", was the one with the lowest perceived skills (2.17 ± 0.99). Following the score range, the data show that only 52 (22.41%) participants had at least good knowledge, and the number of participants with at least good skills was 77 (33.62%). In the current study there was a positive weak correlation between knowledge and total attitude scores ($p < 0.001$, $r = 0.31$). This indicates that students with higher levels of knowledge about children´s environmental health will be more likely to have good skills in children´s environmental health improvement.

In the case of knowledge, there were statistical differences in gender between male (14.50 ± 1.29) and female students (11.54 ± 5.12), t (230) = -4.06, $p = 0.010$, $d = 0.79$, but there were no statistical differences among the different years of the course: first year (11.36 ± 5.03), second year (11.72 ± 5.14) and third year (11.68 ± 5.17), F (2, 231) = 0.11, $p = 0.892$. There were no statistical differences in attendance at sessions on sustainability and nursing: yes (11.99 ± 5.64) and no (11.42 ± 4.86), t (230) = -0.77, $p = 0.443$. In relation to skills, there were no statistical differences in gender: male(40.00

± 2.45) and female students(38.33 ± 7.93), t (227) = -0.42, p = 0.675; years of the course: first year (37.50 ± 7.98), second year (38.72 ± 8.05) and third year (38.80 ± 5.52), F (2, 228) = 0.625, p = 0.536; or in attendance at sessions on sustainability and nursing: yes (38.40 ± 8.33) and no (38.34 ± 7.68), t (227) = -0.06, p = 0.654.

Discussion

The first objective of this study was to adapt and validate among nursing students an English version of knowledge and skills questionnaires concerning children's environmental health that had already been developed and tested with Spanish students. Both questionnaires showed suitable psychometric characteristics in the English-speaking context.

This study used item response theory, as it has strong assumptions and therefore obtains results that are stronger than those of classical measurement theory (Navas, 1994). The intention was to ensure the validity of ChEHK-Q and ChEHS-Q in order to measure the latent traits of “knowledge of children's environmental health” and “skills in children's environmental health” among English-speaking nursing students in an English context. Therefore, with the item analysis and observation of its functioning in the item maps, this study verified that the questionnaires were valid in this context. In addition, it became apparent that different levels of difficulty were useful to gauge students’ knowledge and skills. Also, following item response theory, the parameters of the models for both questionnaires revealed the strength of the items and sample used. There was only one item which overfit in the ChEHK-Q model and two items which overfit in the ChEHS-Q model, but these values were near to the maximum established, and they were functioning properly when they were represented on the item maps.

The second objective was to assess students’ knowledge and skills related to environmental health issues relevant to children. Descriptive analysis showed that most of the students did not have sufficient knowledge and skills, which is a major cause for concern; the percentage of students with at least good knowledge and skills was low. The students knew about children´s vulnerability to environmental pollutants, but they did not know about the effects of pesticides and of the chlorination of water in childhood. They perceived themselves as having good skills to identify environmental risks in the home, but they did not perceive themselves as being capable of identifying neoplastic disease caused by environmental pollutants. There were no statistical differences between the different years of the course or between attendance or non-attendance at the sustainability and nursing session. This may be because the current nursing curriculum does not include environmental issues, and students who have attended a session on sustainability have done so on a voluntary basis. Environmental issues should be introduced using the infusion model where sustainability issues are woven into the existing curriculum (McDermott-Levy et al., 2019). In the first courses, the more theoretical topics should be introduced to achieve practical skills in this area. There was, however, a statistical difference in the knowledge of the male students who had a higher mean, although this could have been caused by the low number of men (four) not being a large enough sample. This phenomenon has not been evaluated previously in studies conducted with nursing

students, and it is necessary to study it in order to implement the required measures for improvement in compliance with environmental principles.

If the results from Spanish undergraduate nursing students enrolled in their first, third and fourth years (Álvarez-García et al., 2018) were compared with the most recent results, the Spanish students achieved better values since the mean scores were higher: 15.19 for the ChEHK-Q and 41.10 for the ChEHS-Q. This aside, although there was a higher number of Spanish students with insufficient or poor knowledge and skills, the percentage of students with at least good knowledge and skills was higher at 47.73% and 44.81%, respectively, for knowledge and skills among the Spanish students.

One study conducted in Arabic countries found that the mean score of undergraduate nursing students with respect to their level of knowledge regarding the potential health-related impact of climate change using a 0–10 scale was 6.23, thus indicating a moderate level of knowledge (Felicilda-Reynaldo et al., 2018), whereas, in the present study, the score was lower (4.46) and did not even reaching the mid-point. The Arabic nursing students were enrolled in their second, third and fourth years, with none enrolled in the first year, and so this could overestimate the results. However, the citizens of Arabic countries have been more affected by climate change; hence, their knowledge of its effects may be greater. Furthermore, these findings may be related to the presence of environmental legislation, which has become a vital part of countries' development plans. It is also possible that the results could be higher because the questionnaire used in Arabic countries was more general and did not detail specific health damage.

Considering these issues, it is clear that the drive should be to ensure that future nurses are cognisant of the importance and fully prepared to respond to health issues that are environmental in nature. These results show that the greater the knowledge, the greater the skills increase along the same trajectory. Although this correlation is not as strong as it could be, it is fundamental that universities strive towards curricula that fully endorse environmental health as a key theme, particularly in the health arena. One previous study (Álvarez-García et al., 2019) undertaken in the United Kingdom and Spain, found that the attitudes of nursing students towards children´s environmental health is favourable and that this foundation needs to be taken forward and developed further with a clear and comprehensive focus on sustainability and environmental aspects using the Curriculum Greening of Higher Education (Junyent and Geli-de-Ciurana, 2008). The findings from this study could inform nurse education and lead to the development of these key areas. The e-NurSus Children intervention (Álvarez-García et al., 2019) could lead the way in this and enhance nurse education concerning these vital environmental health issues.

Limitations

The first limitation was due to social desirability bias since the questionnaires were self-reported. The second limitation was that the ChEHS-Q only measured students' confidence in their skills, and this was not confirmed by an objective observation of the skills in practice. The third limitation was that the sample was derived without randomisation, and therefore the results could be an overestimate as since an unrandomised sample has been used, there is the possibility that the more highly

motivated students who were more confident and knowledgeable were the ones who self-selected to complete the survey. The fourth limitation was that the race and ethnicity of the students were not clarified in the sample, and this may have affected the results. In addition, significantly more women were participants, so the learning patterns may reflect a gender bias.

Conclusion

The Children's Environmental Health Knowledge Questionnaire and the Children's Environmental Health Skills Questionnaire have been shown to be valid and reliable tools for measuring knowledge and perceived skills respectively among English nursing students. These findings showed that the English nursing students who took part in the study were not adequately prepared to identify and act upon environmental problems and related child health issues. Therefore, it is essential to increase, improve and develop child environmental health education for student nurses in the future in order to try to address some of the identified weak areas. It will be important to evaluate the success of this in due course.

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Table 1. Participants' characteristics (*n* = 232)

Characteristics		*n*	%
Age (*M*/*SD*)	23.44/5.59		
Gender			
Male		4	1.70
Female		228	98.30
Year of course			
First		75	32.30
Second		92	39.70
Third		65	28.00
Have attended a session on sustainability and nursing			
Yes, within three months		69	29.74
No		101	43.53
Yes, but over three months ago		62	26.72

Table 2. Parameters of the ChEHK-Q Rasch model

Item	Difficulty (*SE*)	Infit[a]	Outfit[b]
1. The pediatric population is more susceptible to environmental threats due to their biological immaturity.	-1.48 (0.17)	1.07	1.06
2. The increased energy and metabolic consumption of the pediatric population protects children from environmental hazards.	0.01 (0.15)	0.91	0.89
3. The higher rate of cell growth during the pediatric age increases the risk of health effects caused by environmental factors.	-0.59 (0.15)	1.01	0.97
4. Environmental factors do not influence hormonal secretion during puberty.	-0.89 (0.15)	0.91	0.84
5. Nitrogen oxide from fossil fuels in the home and tobacco smoke causes redness and burns on the skin.	1.37 (0.18)	1.09	**1.83**
6. Particles from animals exacerbate asthma crisis.	-1.37 (0.16)	1.09	1.08
7. Increased humidity at home improves respiratory diseases in children.	0.15 (0.15)	1.08	1.30
8. Passive smoking is associated with the development of acute leukemia in children.	-0.10 (0.15)	1.01	0.97
9. Childhood leukemia incidence rates are higher in the areas most exposed to radon.	-0.46 (0.15)	0.97	0.94
10. Overexposure to solar ultraviolet radiations can damage the skin of adults more severely than that of children.	-0.80 (0.15)	0.98	0.95
11. During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed.	0.34 (0.15)	0.91	0.82
12. Lead accumulates in the body affecting the nervous system.	-0.36 (0.15)	0.94	0.90
13. Chronic dietary exposure to mercury (fish and shellfish) is less toxic to children's central nervous system than to adults.	-0.46 (0.15)	0.95	0.92
14. Exposure to pesticides increases the risk of developing attention deficit problems in school-aged children.	0.26 (0.15)	0.93	0.88
15. Children born to smoking mothers during pregnancy are at risk of lower intellectual capacity.	-0.76 (0.15)	1.01	1.06
16. Exposure to organic solvents during fetal development can cause learning disabilities in children.	0.09 (0.15)	1.00	0.95
17. Water containing nitrates can only cause intoxication during childhood.	0.15 (0.15)	0.95	0.92
18. Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic.	0.96 (0.16)	0.88	0.78
19. The major source of childhood exposure to pesticides is through ambient air.	1.67 (0.19)	1.06	0.94
20. The main route of exposure to mercury is through cereal intake.	0.03 (0.15)	0.96	0.95
21. Exposure to lead through diet occurs mainly through fish intake.	1.44 (0.18)	1.00	1.01
22. Food colorings and preservatives are associated with central nervous system problems.	0.91 (0.16)	0.86	0.75
23. Genetically modified foods cause fewer allergic reactions in children.	-0.01 (0.15)	1.02	1.00
24. Schools and nurseries are environmentally safe places.	-0.18 (0.15)	0.99	0.95
25. Children are exposed to higher concentrations of air pollutants at home than outdoors.	0.07 (0.15)	1.15	1.09
26. Parks and gardens are the areas with the least environmental pollutants where children can play.	0.03 (0.15)	1.11	1.15

Note. Values exceeding the limits set for infit and outfit (0.80–1.20) are in boldface.

[a]Infit = Weighted Mean Square Fit.

[b]Outfit = Unweighted Mean Square Fit.

Table 3. Parameters of the ChEHS-Q rating scale model

	Item	Difficulty (*SE*)	Infit[a]	Outfit[b]
1.	I am able to assess the main environmental risks to which a child is exposed.	-0.23 (0.09)	0.94	0.98
2.	I am NOT able to identify the environmental risks that can cause respiratory diseases in a child.	-0.71 (0.09)	0.99	0.97
3.	I am able to identify the environmental risks that can cause neoplastic diseases in a child.	1.51 (0.09)	**1.32**	**1.31**
4.	I am NOT able to identify the environmental risks that can cause neurological disorders in a child.	0.52 (0.09)	**1.31**	**1.31**
5.	I am able to provide health education to parents about the main contaminants in their child's food.	0.73 (0.09)	1.23	1.24
6.	I am NOT able to identify the environmental risks in playgrounds.	-0.37 (0.09)	1.18	1.22
7.	I am able to provide health education to parents about actions to minimize environmental risks to which a child is exposed when playing outdoors.	0.05 (0.09)	0.72	0.71
8.	I am NOT able to identify the environmental risks in a child's home.	-0.85 (0.09)	0.85	0.81
9.	I am able to provide health promotion to parents about environmental risks at home.	-0.43 (0.09)	0.75	0.73
10.	I am able to identify the environmental risks in a child's school.	-0.26 (0.09)	0.73	0.73
11.	I am NOT able to identify the actions needed to combat environmental risks in a child's school.	-0.09 (0.09)	0.75	0.71
12.	I do NOT feel able to do my job as a nurse in a pediatric environmental health specialty unit.	0.14 (0.09)	1.16	1.28

Note. Values exceeding the limits set for infit and outfit (0.70–1.30) are in boldface.
[a]Infit = Weighted Mean Square Fit.
[b]Outfit = Unweighted Mean Square Fit.

Table 4. Statistics of Likert categories for the ChEHS-Q rating scale model

Likert category	Threshold (*SD*)	Infit	Outfit
0			
1	-2.00 (0.09)	0.97	0.96
2	-1.24 (0.06)	0.82	0.84
3	0.62 (0.05)	0.85	0.83
4	2.63 (0.08)	1.17	1.11

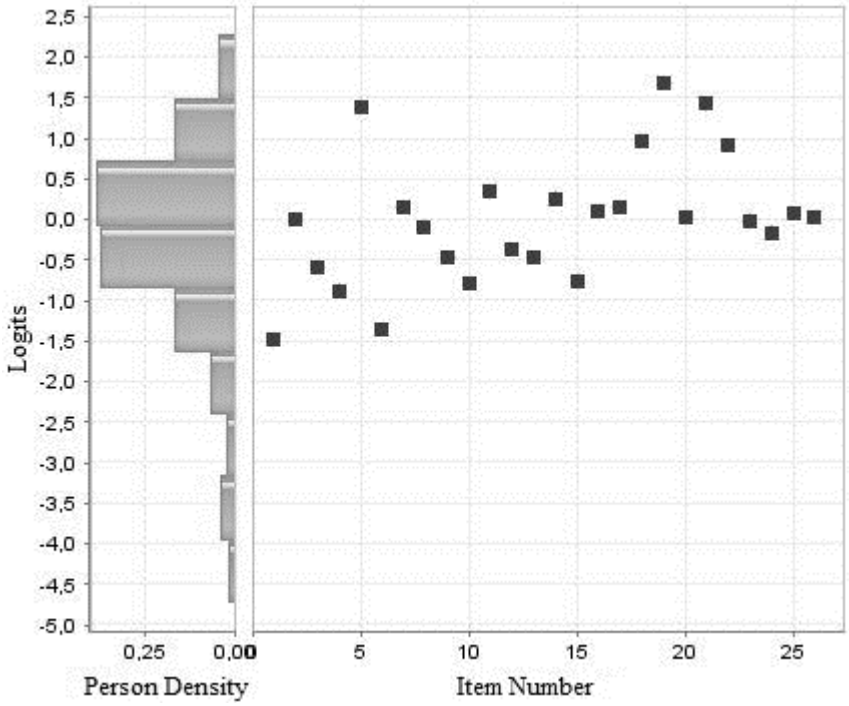

Figure 1. ChEHK-Q item map. The left side shows the distribution of the scores obtained by students, expressed in Logit units and known as person density (θ). The right side shows the distribution of items according to their difficulty (β). The horizontal axis shows the items ordered from 1 to 26. The vertical axis shows the difficulty index of the items; higher values indicate more difficult items. Values higher than 0 denote high knowledge; values lower than 0 indicate low knowledge.

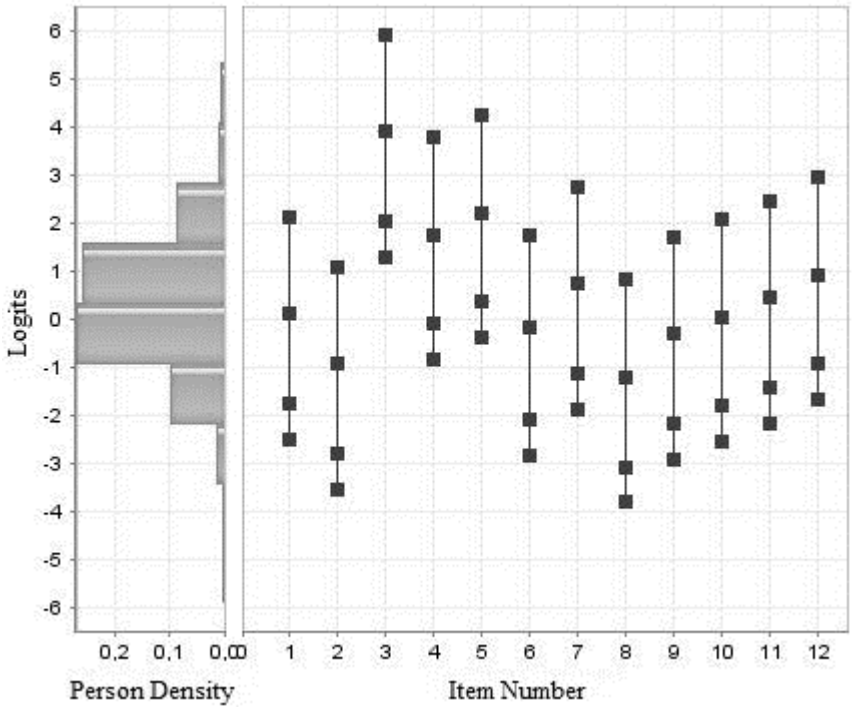

Figure 2. ChEHS-Q item map. The left side shows the distribution of the scores obtained by students, expressed in Logit units and known as person density (θ). The right side shows the distribution of items according to their difficulty (β). The horizontal axis shows the items ordered from 1 to 12. The vertical axis shows the difficulty index of the items; higher values indicate more difficult items. Values higher than 0 denote high skills; values lower than 0 indicate low skills.