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Educational habitability scale for the classroom: Preliminary psychometric properties among primary school teachers in southern Sinaloa

Escala de habitabilidad educativa del aula: propiedades psicométricas preliminares en docentes de primaria del sur de Sinaloa

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ABSTRACT

The physical conditions of the classroom are part of the conditions for teaching and learning, yet in primary schools of northwestern Mexico they are rarely measured from the teachers' perspective with instruments supported by validity evidence. Using the preliminary data cut from the pilot survey of project FZ-HAB-0018 on the Factoriza UAS platform, this study described the preliminary psychometric properties of a twelve-item educational habitability scale for the classroom, with two dimensions, Environmental comfort of the classroom and Conditions for learning in the classroom, answered by primary school teachers in southern Sinaloa, Mexico. With a cross-sectional design, 11 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and the Spearman correlation between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was moderate for Environmental comfort ($\alpha = .601$; $\omega = .652$) and for Conditions for learning ($\alpha = .671$), where the item on teaching materials did not covary with the rest. The factor analysis was not interpretable because the sample had fewer cases than items. The dimensions were positively associated ($\rho = .768$, 95% CI [.223, .947]). Outdoor noise received the lowest rating. The findings do not yet provide structural validity evidence and point to revisions of the instrument.

Keywords: classroom habitability; indoor environmental quality; primary school teachers; psychometric evidence

RESUMEN

Las condiciones físicas del aula forman parte de las condiciones de enseñanza y aprendizaje, pero en las escuelas primarias del noroeste de México rara vez se miden desde la percepción docente con instrumentos con evidencias de validez. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0018 de Factoriza UAS, las propiedades psicométricas preliminares de una escala de habitabilidad educativa del aula de doce reactivos, con dos dimensiones: Confort ambiental del aula y Condiciones para aprender en el aula, respondida por docentes de primaria del sur de Sinaloa. Con diseño transversal, se analizaron 11 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y la correlación de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue moderada en Confort ambiental ($\alpha = .601$; $\omega = .652$) y en Condiciones para aprender ($\alpha = .671$), donde el reactivo sobre los materiales didácticos no covarió con el resto. El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos. Las dimensiones se asociaron de forma positiva ($\rho = .768$, IC 95 % [.223, .947]). El ruido exterior fue el aspecto peor valorado. Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento.

Palabras clave: habitabilidad del aula; calidad ambiental interior; docentes de primaria; evidencias psicométricas

INTRODUCTION

The classroom is the space where girls, boys and teachers spend most of the school day, and its physical conditions are part of the setting in which teaching and learning take place. Temperature, ventilation, acoustics, lighting, furniture and available space are not secondary aspects of infrastructure: recent research links them to the academic performance, health and well-being of students and teachers.

A scientometric analysis of research on the school built environment and child health identified thermal comfort, indoor air quality, perception and performance as among the core themes of the field (Zhang and Meng, 2025). A recent systematic review found that higher temperatures are generally associated with lower academic outcomes, with greater vulnerability in lower-income communities (Umerani et al., 2026).

In warm-climate regions such as southern Sinaloa, heat and classroom ventilation are an everyday concern. Studies of naturally ventilated classrooms in warm climates have documented seasonal thermal discomfort, noise from the street and the schoolyard, and variable ratings of air freshness (Afifi et al., 2025).

In northwestern Mexico, research on comfort in educational spaces has focused on university classrooms in Baja California, where studies have documented thermal discomfort when indoor temperatures fall outside the comfort range, as well as insufficient daylight levels (de la Cruz Chaidez et al., 2022; Rincón-Martínez, 2023). The habitability of primary school classrooms, by contrast, has received less empirical attention in the region.

Teachers are privileged informants on classroom habitability because they spend the entire school day there and observe how physical conditions relate to their students' attention and behavior. Their perception, however, is not equivalent to an objective measurement: a recent review of indoor air quality in schools found that educators' subjective perceptions do not agree with objective measurements (Cooke et al., 2026). For this reason, a teacher-perception instrument with validity evidence is useful for diagnosis and monitoring, provided that what it does and does not measure is acknowledged.

Project FZ-HAB-0018 on the Factoriza UAS platform set out to develop and test a classroom educational habitability scale for primary school teachers, with two dimensions: Classroom Environmental Comfort and Classroom Learning Conditions. On the platform, the project is listed as a validation of the scale; however, this article reports the results of the first pilot survey from a very small preliminary data cut, which does not yet support claims of validation, only an initial review of the instrument's psychometric properties.

The general objective was to describe the preliminary psychometric properties of a classroom educational habitability scale, based on the preliminary data cut from its pilot survey of primary school teachers in southern Sinaloa.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to explore the relationship between the scores on the two dimensions. The project did not state any hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

CLASSROOM HABITABILITY AS A CONDITION FOR TEACHING AND LEARNING

The notion of habitability, as applied to educational spaces, refers to the extent to which the classroom provides physical conditions suited to the activities carried out in it. The literature on the indoor environmental quality of school buildings breaks it down into thermal comfort, air quality, visual comfort and acoustic comfort, to which furniture and spatial layout are added.

In three university buildings in a hot-summer, cold-winter region of China, Weng et al. (2023) compared indoor environmental quality and the satisfaction of teachers and students. They recommended improving natural ventilation, giving users control over windows and temperature, and increasing illuminance on the work plane to enhance learning efficiency.

The relationship between classroom conditions and learning has been documented mainly for temperature and air quality. The systematic review by Umerani et al. (2026) compiled observational studies in primary and secondary education and concluded that higher temperatures are generally associated with poorer academic outcomes; it therefore recommended investing in

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climate-resilient school infrastructure that includes cooling, ventilation and insulation.

Cooke et al. (2026), for their part, concluded that indoor air pollutants are negatively associated with students' cognitive and academic performance, and proposed a whole-school approach that considers both student learning and the experience of teaching staff.

ENVIRONMENTAL COMFORT: TEMPERATURE, VENTILATION, VISIBILITY, AND ACOUSTICS

Acoustic comfort holds a special place in the teaching experience. The scoping review by Mealings et al. (2024) found vocal health to be the most studied aspect, and most of its findings show that higher noise levels or larger numbers of students are negatively associated with teachers' health and well-being.

In a study of primary and secondary school teachers in Finland, Patjas et al. (2021) identified background noise as the most disruptive factor for voice in the classroom and associated voice problems with greater stress and lower work ability.

Bottalico et al. (2023) showed that, in primary school classrooms, better acoustic conditions are required for children to achieve good speech intelligibility, especially when the teacher's voice is impaired. In the Chinese-language literature, Xie and Huang (2024) proposed incorporating acoustic indicators, such as reverberation time control, into the spatial design of classrooms.

The Classroom Environmental Comfort dimension of the instrument under study captures these facets from the teacher's perspective: heat during the school day (R1, reverse-scored), the inflow of fresh air (R2), the visibility of the blackboard from any location (R3), how clearly students hear the teacher without the teacher having to raise their voice (R4), interruption of lessons by outside noise (R5, reverse-scored), and the comfort of the furniture (R6). The dimension therefore brings together thermal, visual, acoustic, and ergonomic conditions. The literature treats these as distinct components of environmental quality that may vary independently depending on the orientation, construction, and equipment of each classroom.

TEACHERS' PERCEPTIONS AS A SOURCE OF INFORMATION ON THE CLASSROOM

Measuring classroom habitability through teachers' perceptions has advantages and limitations that should be made explicit. The advantages include the possibility of gathering information from many classrooms at low cost, without measuring equipment, and of capturing the experience of those who spend the entire school day in the space and observe its consequences in class.

Research on teacher voice also shows that the perception of acoustic conditions and air quality is associated with teachers' own symptoms, stress and work capacity (Patjas et al., 2021); thus, perception is not merely an imperfect proxy for measurement but a relevant indicator of occupational well-being in its own right (Mealings et al., 2024).

Two limitations stand out: the documented lack of agreement between perception and objective measurement of air quality in schools (Cooke et al., 2026), and occupants' adaptation to thermal conditions.

In naturally ventilated educational buildings in Baja California, Rincón-Martínez (2023) found that occupants showed greater adaptation to temperatures above neutral through actions aimed at restoring comfort. This implies that the assessment of heat depends on expectations and on the adjustment options available. For this reason, a teacher-perception instrument should be interpreted as a measure of experienced habitability and complemented, where possible, with physical measurements in the classroom.

CONDITIONS FOR LEARNING: SPACE, CLEANLINESS, LIGHTING, AND MATERIALS

Beyond environmental comfort, classroom habitability also involves conditions of order, space, and equipment. With respect to furniture, Loredan et al. (2024) found a high degree of mismatch between the dimensions of school furniture and the anthropometric measurements of primary school and university students, along with musculoskeletal pain from primary school onward. Fidelis and Ogunlade (2022) documented large mismatches in Nigerian schools and the need for furniture design standards.

As for lighting, de la Cruz Chaidez et al. (2022) found natural light levels below the recommended minimum in the classrooms studied in Tijuana. In naturally ventilated primary

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school classrooms in a hot, arid climate, Afifi et al. (2025) found that seat location, ventilation and lighting were generally rated favorably, with variation between schools and classrooms.

The Conditions for Learning in the Classroom dimension includes cleanliness during the school day (R7), space for students to move around (R8), sufficient lighting to read without strain (R9), the perception that classroom conditions distract students (R10, reverse-scored), the availability of teaching materials (R11), and the appraisal of the classroom as a pleasant place to learn (R12). Unlike the first dimension, it combines material conditions with an overall appraisal and a perceived consequence for students' attention. Given the cross-sectional design, the relationship between the two dimensions should be understood as an association, not as a relationship of dependence.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data come from survey LEV-0023, "Southern Sinaloa Pilot · Classroom Habitability (Teachers)," of project FZ-HAB-0018 on the Factoriza UAS platform, and from the frozen dataset DST-0023, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only survey in the project. The project is registered on Factoriza with a mixed-methods route; the results package contains only the survey component, which is the component analyzed here.

POPULATION, SAMPLE, AND DATA CUTOFF

The survey population was defined as primary school teachers in southern Sinaloa working in schools that authorized their participation. According to the Factoriza log, 32 people opened the questionnaire and 11 completed it; no cases were excluded for quality control, so 11 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 11 cases out of a target of 100, and data collection was still open, in the field, as of the cut-off date. With 11 cases for 12 items, the ratio is 0.9 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and the sample is the first condition that the methodological literature asks researchers to check in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Classroom Habitability Scale for Primary School Teachers was administered. It comprises twelve items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into two six-item dimensions: Classroom Environmental Comfort (R1 to R6) and Classroom Learning Conditions (R7 to R12). Three items are reverse-worded (R1, "The classroom where I teach is hot during the school day"; R5, "Outside noise interrupts my lessons"; and R10, "The conditions in my classroom distract the students") and are already recoded in the data matrix. After recoding, a higher score indicates better perceived conditions. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Classroom environmental comfort	The classroom where I teach is hot during the school day	Yes
R2	Classroom environmental comfort	Fresh air enters my classroom during lessons	No
R3	Classroom environmental comfort	Students can see the blackboard from anywhere in the classroom	No
R4	Classroom environmental comfort	In my classroom, students hear me clearly without my having to raise my voice	No
R5	Classroom environmental comfort	Outside noise interrupts my classes	Yes
R6	Classroom environmental comfort	The furniture in my classroom is comfortable for the students	No
R7	Conditions for learning in the classroom	My classroom is kept clean throughout the school day	No

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Code	Dimension	Item	Reverse
R8	Conditions for learning in the classroom	In my classroom there is space for students to move around	No
R9	Conditions for learning in the classroom	The lighting in my classroom allows me to read without effort	No
R10	Classroom learning conditions	The conditions in my classroom distract the students	Yes
R11	Classroom learning conditions	The teaching materials in my classroom are within the students' reach	No
R12	Classroom learning conditions	My classroom is a pleasant place to learn	No

Note. Classroom habitability scale for primary school teachers. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the data matrix provided. Source: Factoriza UAS, project FZ-HAB-0018, survey LEV-0023, dataset DST-0023.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze the DST-0023 dataset with a cryptographic hash, generated the data matrix with the reverse-scored items recoded, and produced the descriptive and internal-consistency analyses (runs RUN-00121 to RUN-00125). The supplementary analyses were performed using the data file and the item dictionary exported by the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values of each item. It also calculated the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items; when any item correlates or loads negatively relative to the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable. It also attempted an exploratory factor analysis of the twelve items, preceded by the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), item-level sampling adequacy (Lorenzo-Seva and Ferrando, 2021), and Bartlett's test of sphericity (Bartlett, 1950). The number of factors was determined by parallel analysis (Horn, 1965), with minimum residual extraction and oblimin rotation.

Finally, it estimated the relationship between the mean scores of the dimensions using Spearman's coefficient and its 95% confidence interval, computed via the Fisher transformation with the Bonett and Wright (2000) standard error.

Reference values for interpreting the indices, such as 0.60 for the KMO, are treated as guidelines rather than decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is left for future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous, and took place in schools that authorized the administration of the instrument. Factoriza UAS records express informed consent online and does not collect names, email addresses or other identifying data. In a study in which teachers assess the conditions of their workplace, anonymity protects respondents from school management and educational authorities.

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STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following tools were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive and internal consistency analyses; a Python analysis program with fixed, validated procedures, for omega, exploratory factor analysis and correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, writing a first draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 32 individuals who opened the questionnaire, 11 completed it and were analyzed, with no exclusions for quality control. Most of those who started the questionnaire did not finish it, which should be reviewed in the field administration procedures, for example with regard to the time of day at which participants are invited to respond. All analyzed cases answered all twelve items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	32
Completed questionnaires	11
Cases excluded by quality control	0
Cases analyzed	11
Items	12

Note. Survey “Southern Sinaloa Pilot · Classroom Habitability (Teachers)” (LEV-0023); population: primary school teachers in southern Sinaloa, with school authorization; territory: southern Sinaloa, in primary schools that authorized their participation. Dataset DST-0023, fingerprint 8ba1330fb6f702fc. Source: Factoriza UAS. Preliminary cut-off: n = 11 out of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. For Environmental Comfort, the highest mean was for R4, the clarity with which students hear the teacher without the teacher having to raise their voice (*M* = 3.73, *SD* = 0.79). The lowest was for R5, the interruption of classes by outside noise in its recoded version (*M* = 2.09, *SD* = 1.04). This was also the lowest mean of the entire set, with 36% of responses at the minimum value; that is, a substantial proportion of teachers believe that outside noise interrupts their classes.

Heat during the school day, in its recoded version (R1), and the intake of fresh air (R2) both had *M* = 2.91 (*SD* = 1.22 and 1.30, respectively), and visibility of the blackboard (R3) had *M* = 2.82 (*SD* = 1.17).

In Conditions for learning, the highest mean was for R12, the classroom as a pleasant place to learn (*M* = 3.36, *SD* = 1.12), followed by R8, space for students to move around (*M* = 3.27, *SD* = 0.90), and the lowest was for R7, classroom cleanliness during the school day (*M* = 2.82, *SD* = 1.08). Lighting (R9) and students’ distraction due to classroom conditions, in its recoded version (R10), both had *M* = 3.00, and the reach of teaching materials (R11) had *M* = 2.91 (*SD* = 1.14). Overall, most means fell around the midpoint of the scale, with less favorable ratings for noise, cleanliness, visibility, heat, and ventilation.

Table 3. Descriptive statistics for the items.

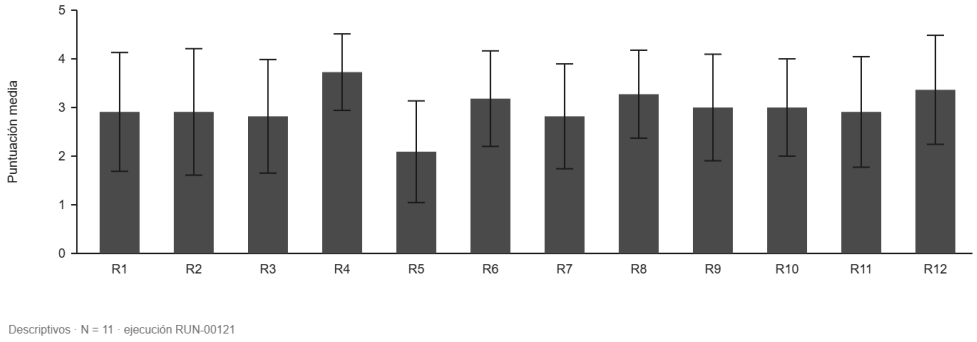
Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.91	1.22	0.21	-0.92	9%	9%
R2	2.91	1.30	-0.13	-0.88	18%	9%
R3	2.82	1.17	-0.04	-1.91	9%	45%
R4	3.73	0.79	-0.94	1.65	9%	9%

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Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R5	2.09	1.04	0.43	-0.93	36%	9%
R6	3.18	0.98	0.35	-0.59	27%	9%
R7	2.82	1.08	-0.15	-1.39	9%	36%
R8	3.27	0.90	-0.65	-1.55	27%	55%
R9	3.00	1.10	-0.56	-1.11	9%	45%
R10	3.00	1.00	0.73	-0.13	36%	9%
R11	2.91	1.14	0.21	-0.07	9%	9%
R12	3.36	1.12	-0.89	0.81	9%	9%

Note.N = 11. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item–total correlation column across the twelve items is omitted because it combines two dimensions; the item–total correlation by dimension is presented in Table 4. Run RUN-00121 of Factoriza UAS. Preliminary data cut: n = 11 of a target of 100, with data collection still open.

Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 reports the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary program. The alpha values were identical in both calculations. Classroom environmental comfort yielded α = .601 and ω = .652. Classroom learning conditions yielded α = .671; omega is not reported because R11, the scope of the teaching materials, correlated negatively with the rest of the dimension.

The item-level analysis pinpoints the problems.

In Environmental comfort, R6, comfort of the furniture, had the highest corrected item-total correlation (.706), and its deletion would reduce alpha to .407, whereas the remaining items showed low correlations, ranging from .242 to .361. The internal consistency of the dimension therefore rests largely on a single item. In Conditions for learning, R8, space to move around, was the most coherent item (.594), followed by R10 (.551) and R9 (.542), while R11 showed a correlation of -.059, and its deletion would raise alpha to .780.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Classroom environmental comfort	R1	.267	.588
Classroom environmental comfort	R2	.361	.546
Classroom environmental comfort	R3	.247	.594
Classroom environmental comfort	R4	.242	.590
Classroom environmental comfort	R5	.267	.582
Classroom environmental comfort	R6	.706	.407
Conditions for learning in the classroom	R7	.485	.598
Conditions for learning in the classroom	R8	.594	.572
Conditions for learning in the classroom	R9	.542	.576
Conditions for learning in the classroom	R10	.551	.578

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Dimension	Item	Corrected item-total r	α if item deleted
Conditions for learning in the classroom	R11	-.059	.780
Conditions for learning in the classroom	R12	.435	.617

Note.N = 11. Scale from 1 to 5; reverse-scored items R1, R5, and R10 are shown recoded. Run RUN-00121 of Factoriza UAS. Preliminary data cut: n = 11 out of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Observation
Classroom environmental comfort	6	11	.601	.652	
Classroom learning conditions	6	11	.671		Reverse-keyed items: R11; ω not interpretable

Note.N = 11. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension, with 6 items each: Classroom Environmental Comfort = .601 (run RUN-00122); Conditions for Learning in the Classroom = .671 (RUN-00124). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 11 out of a target of 100, with data collection still open.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated interpretably, and its results are not presented in tables. With 11 cases and 12 items, the correlation matrix is not invertible, so the indices that depend on its inverse cannot be interpreted: the overall measure of sampling adequacy yielded a numerical value of .180, well below the indicative reference value of 0.60, and Bartlett's test, $\chi^2(66) = 428.28$, is artificially inflated when the determinant of the matrix is practically zero.

Parallel analysis suggested three factors, but with fewer cases than items, that solution has no support. These results are reported in the reproducibility appendix, but they provide no evidence about the dimensionality of the instrument and should not be cited as such.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlation between the mean scores of the two dimensions, based on 11 cases. The relationship between Environmental Comfort and Conditions for Learning was positive and strong, $\rho = .768$, 95% CI [.223, .947], $p = .006$. The interval excludes zero but is very wide, as expected for a sample of this size, and its lower bound is compatible with a barely moderate association.

Table 6. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Classroom Environmental Comfort and Classroom Learning Conditions	11	.768	[.223, .947]	.006

Note.α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum residual model, without reverse-scoring items. Complete cases per dimension. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0023_FZ_HAB_0018. Preliminary cutoff: n = 11 out of a target of 100, with data collection still open.

DISCUSSION OF RESULTS

The aim of this study was to describe the preliminary psychometric properties of a classroom educational habitability scale in a pilot study with primary school teachers from southern Sinaloa. The main finding is that both dimensions showed moderate internal consistency and that their behavior depends on only a few items: in Environmental Comfort, on the comfort of the furniture; in Conditions for Learning, on space, lighting, and the absence of distractions, whereas the accessibility of teaching materials did not covary with the other items.

With only 11 cases, all coefficients are provisional: the simulation literature on alpha and omega coefficients has been based on much larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated.

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The low coherence of the environmental comfort items, except for furniture, is consistent with a view of classroom environmental quality as a set of distinct components (thermal, acoustic, visual and ergonomic) that may vary independently depending on the orientation, construction and equipment of each classroom (Weng et al., 2023; Zhang and Meng, 2025).

A classroom can be hot while also having good acoustics and good visibility of the blackboard. If this pattern is confirmed in the final sample, it will be worth considering whether the dimension should be treated as a formative index of conditions rather than as a reflective scale in which all items are expected to covary.

The descriptive statistics point to substantive problems that are consistent with the literature. Outdoor noise was the lowest-rated aspect, in line with studies identifying background noise as the most disruptive factor for teachers' voices (Patjas et al., 2021), with evidence linking it to teachers' health and well-being (Mealings et al., 2024), and with the annoyance caused by street and playground noise documented in naturally ventilated classrooms in warm climates (Afifi et al., 2025).

The intermediate ratings for heat and ventilation are relevant in a warm region, given the association between high temperatures and lower academic performance (Umerani et al., 2026); the cleanliness and visibility of the blackboard emerge as conditions that warrant attention in school management.

The behavior of R11, the accessibility of teaching materials, warrants separate consideration. Unlike the other items in its dimension, which describe conditions of the physical space, R11 refers to the arrangement of materials, a decision that depends largely on the teacher's pedagogical organization and on the resources available to the school.

That it did not covary with space, lighting or cleanliness suggests that it measures content distinct from classroom habitability understood as a physical condition, and that it could be reworded or moved to a learning-resources dimension. The decision rests with the authors and should be made at the final data cutoff, because with 11 cases a single atypical response can change the sign of a correlation.

Two findings call for additional caution. The strong association between the two dimensions may indicate that teachers appraise classroom habitability as a whole, but it may also reflect a common response style in a very small sample; moreover, as Cooke et al. (2026) have shown for air quality, teachers' perceptions are no substitute for objective measurement of conditions.

Furthermore, response quality should be checked before the final analysis because, in small samples, careless or extreme response patterns can markedly distort correlations (Ward and Meade, 2023).

CONCLUSIONS

The study met its objective within the scope permitted by a preliminary sample of 11 cases. In its pilot administration, the classroom educational habitability scale from project FZ-HAB-0018 showed moderate internal consistency for Classroom Environmental Comfort (α = .601; ω = .652) and for Classroom Learning Conditions (α = .671), with one item, R11, that did not covary with its dimension. The exploratory factor analysis could not be estimated in an interpretable way because the sample has fewer cases than items.

The two dimensions were positively associated. The results do not yet provide evidence of structural validity, nor do they allow the instrument to be presented as a scale with sufficient validity evidence; their main use is to identify the items that should be revised.

The limitations are substantial. The sample of 11 cases, against a target of 100 (0.9 cases per item), precludes estimating the internal structure and makes all statistics unstable; data collection was still ongoing, and most of those who started the questionnaire did not complete it. No information is available on the participating schools, the selection procedure, or the characteristics of the teachers and their groups, and the student-support component of the mixed pathway is not part of the analyzed package. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

These results point to several decisions for the authors. The first is to revise R11, the scope of teaching materials, which may relate more to pedagogical organization than to the habitability of the space. The second is to assess whether Environmental comfort should be retained as a reflective scale or treated as an index of conditions, given that its thermal, acoustic, visual, and ergonomic components did not covary in this cross-section.

The third is to record the school, shift, grade and number of students, so that variation

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between classrooms can be analyzed. None of these decisions was made in the present analysis, which retains the original twelve items.

From a school management perspective, the descriptive statistics of this pilot, although provisional, point to specific conditions that can be addressed through low-cost interventions rather than major construction: controlling outside noise by relocating playground activities and selectively closing openings, cleaning during the school day, arranging furniture to improve visibility of the blackboard, and cross-ventilation during hot periods.

Furniture comfort, the item on which the internal consistency of the comfort dimension was concentrated, also suggests that it would be advisable to review whether the furniture fits students' body measurements, as the literature on school ergonomics recommends (Fidelis and Ogunlade, 2022; Loredan et al., 2024).

As directions for future research, we propose completing data collection up to the planned target, repeating the exploratory factor analysis once the number of cases allows it, and then evaluating the resulting structure with confirmatory factor analysis in an independent sample.

Teachers' perceptions could be compared with measurements of temperature, noise level and lighting in a subsample of classrooms, and with indicators of student attention, as envisaged in the original project design. An instrument with documented validity evidence would make it possible to diagnose the habitability of primary school classrooms in the region and to guide investment in school infrastructure adapted to the hot climate.

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