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The Spatial Thinking Ability Test (STAT-24): Classroom administration, scoring, and data management

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Tsendsuren Tserendolgor¹, Nyamgerel Choijilsuren²

¹Geography department, National University of Mongolia, Ulaanbaatar, Mongolia;

²Chemistry department, National University of Mongolia, Ulaanbaatar, Mongolia

Social and Science



tsendsuren tserendolgor

national university of mongolia

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Protocol status: Working

We use this protocol and it's working

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Keywords: spatial thinking ability test, category balance, cultural contextualization, classroom application, geography education, STAT-24, data management of the spatial thinking ability test, spatial thinking ability test, instrument for secondary geography education, secondary geography education, validity, suitable for research use, privacy

Disclaimer

De-identified data that support the findings are available from the corresponding author upon reasonable request. To protect participant privacy and comply with institutional and ethical guidelines, all identifying information (e.g., student names, school names, class numbers) has been removed.

Abstract

This protocol standardizes the classroom administration, scoring, and data management of the Spatial Thinking Ability Test (STAT-24), a category-balanced instrument for secondary geography education. It details preparation (ethics, consent, anonymized IDs), delivery in paper, a verbatim instruction script, 45-minute timing (60 minutes with approved accommodations), incident logging, and secure collection of materials. Scoring converts A–E responses to 1–5, with quality control via double entry or automated checks, and versioned separation of raw versus derived datasets. Data management emphasizes privacy (no PII in analysis files, encrypted ID crosswalk) and documentation (README, data dictionary, checksums). Optional analyses outline CTT, CFA (WLSMV), IRT (NRM), and DIF procedures to support validity and fairness evidence. Expected outputs include an anonymized UTF-8 CSV with item responses and category subscores suitable for research use and formative feedback. This protocol was applied in 2024–2025 with N=923 Grade-11 students across 7 schools in Mongolia.

Attachments



[STAT24_csv_template...](#)

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[STAT24_data_dictiona...](#)

2KB



[STAT24_incident_log...](#)

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[STAT24_instruction_s...](#)

95KB



[STAT24_sample_datase...](#)

2KB

Guidelines

Public package includes administration workflow, templates, and a sampler booklet to preserve test security; the full STAT-24 booklet and answer key can be provided on reasonable request for non-high-stakes research or instructional use.

- **Ethics & privacy.** Obtain IRB/ethics approval; collect and securely store consent. Never include PII in analysis files; keep the ID crosswalk separate and access-restricted.
- **Standardization.** Use the provided instruction script verbatim; keep environmental conditions consistent (timing, aids, seating).
- **Security.** Protect test content; store booklets separately from answer sheets; control digital access (session codes, device checks).
- **Contingencies.** Maintain a paper fallback for digital delivery; log all incidents and deviations.
- **Data integrity.** Use UTF-8 CSV; validate ranges and missingness; version all files; separate raw vs. derived datasets.
- **Accommodations.** Provide extended time only when pre-approved; document accommodations in the incident log (no PII).
- **Interpretation caution.** Category-level decisions should favor class-level patterns and repeated measures over high-stakes, single-sitting inferences.

Materials

- **Documents:** STAT-24 booklet (PDF/print), answer sheet template, standardized instruction script, consent forms, IRB letter.
- **Software:** R (packages: lavaan, mirt, difr, GDINA), Excel Sheets
- **Hardware:** Printer/scanner

Safety warnings

 No explicit warnings or safety cautions on these pages.

Ethics statement

This study received approval from the National University of Mongolia IRB (#2024-013; #2025-025); written guardian consent was obtained, participation was voluntary, and all data were de-identified.



Before start

Before you begin

- Ethics & approvals: IRB/ethics approval obtained; parental and/or student consent collected and archived.
- Access & roles: Assign a coordinator (overall), invigilators (in-room), and a data manager (post-session).
- Delivery mode: Choose Paper (booklet + answer sheet) or Digital (e.g., Exam.net). Prepare backups for outages.
- Anonymization plan: Decide on student ID schema, store crosswalk securely, and keep separate from research data.
- Answer key & templates: Verify the STAT-24 answer key; prepare scoring sheet and CSV template.

Estimated prep time: 45–90 min.



Step 1 - Preparation (15–30 min)

1. Confirm IRB/ethics approval and collect required consent (parental).
2. Create anonymized student ID list and secure the ID↔name crosswalk separately.
3. Verify answer key and scoring sheet; prepare CSV template (UTF-8).
4. Brief invigilators on standardized script, timing (45 min; 60 min with approved accommodations), and incident logging.

Step 2 — Room setup & sign-in (10–15 min)

1. Arrange seating to minimize collaboration; display a visible timer.
2. Distribute anonymized IDs; verify each student records the correct ID on the answer sheet/form.
3. Perform a quick 5-student spot-check for correct ID entry.

Step 3 — Standardized instructions (2–3 min, read verbatim)

3

Note

“This is a test of spatial thinking. Work independently. You have 45 minutes. If you finish early, review your answers. Do not use external aids. Raise your hand only for procedural questions.”

Start the timer.

Step 4 — Administration (45 minutes; 60 with accommodations)

1. Invigilators circulate quietly; no content assistance.
2. Record incidents (late arrivals, suspected collaboration, device failure)

Step 5 — Collection & reconciliation (5–10 min)

1. Collect all booklets and answer sheets (paper).
2. Reconcile counts with the roster; investigate discrepancies and document resolutions.
3. Store test booklets separately from answer sheets to protect item security.

Step 6 — Scoring & data entry (≈2–3 hours / 100 students)

1. Encode responses A–E → 1–5 (blank = NA/0 as defined in your codebook).



2. Enter data into CSV (UTF-8). Columns: ID, Item1...Item24, optional non-identifying demographics.
3. Apply official STAT-24 answer key; compute total and category subscores.
4. Save raw (verbatim) and scored/derived datasets as separate versioned files.

Step 7 — Data management & anonymization (30–60 min)

- 7
 1. Remove PII (names, class, school codes) from all analysis files.
 2. Store the ID crosswalk in a restricted, encrypted location; keep separate from analysis data.
 3. Create/update a README with file versions, dates, checksums, and responsible person.
 4. For sharing, provide only anonymized data and documentation.

Step 8 — Analysis pipeline (research use; time varies)

- 8
 1. CTT: item difficulty (target ~0.20–0.80), discrimination, item-total correlations.
 2. CFA (WLSMV): confirm category structure; report fit indices and factor loadings.
 3. IRT (NRM): inspect option information and discrimination; flag uninformative options.
 4. Fairness: DIF checks (e.g., gender, location) and report flagged items.
 5. Summarize category-level results and note limitations (precision, classification reliability).

Protocol references

Lee, Jongwon, and Robert Bednarz. 2012. "Components of Spatial Thinking: Evidence from a Spatial Thinking Ability Test." *Journal of Geography* 111 (1): 15–26. <https://doi.org/10.1080/00221341.2011.583262>.

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