MLRC - Beijing 2025 Cohort – ISB Team #5

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Note

This project is currently a work in progress. The literature review and preliminary framework have been completed. Findings from the science pilot study and mathematics implementation phase are still being analyzed and are therefore not presented at this time.

Research Question

How do translanguaging pedagogies support multilingual middle school students' sense-making in mathematics and science classrooms?

Purpose of the Study

To synthesize the literature and develop a practical framework to design translanguaging-rich STEM instruction.

Literature Review Methodology

Search Process

Three systematic reviews conducted using https://elicit.com/

- Translanguaging in Mathematics
- Translanguaging in Science
- Translanguaging and Sense-Making

Screening Criteria

- *Multilingual learners*
- *Translanguaging focus*
- *STEM context*
- *Empirical evidence*

Final Sample

- *24 studies included*

Analysis

Thematic synthesis of findings extracted through Elicit systematic reviews, focusing on: Translanguaging pedagogies, Sense-making mechanisms, Learning outcomes, Teacher practices, and Implementation factors and challenges.

Literature Review
Why Translanguaging Matters

Across contexts, multilingual learners are often expected to learn STEM through a dominant language.

This is not unique to one country *– studies from Hong Kong, South Africa, Germany, Lebanon, and the United States all report similar challenges.*

Challenges:

- *Limited participation*
- *Reduced access to disciplinary reasoning*
- *Deficit views of multilingual learners*
- *Difficulty explaining scientific and mathematical ideas*

Key argument from the literature:
Students learn more effectively when they can use their full linguistic and semiotic repertoires.

Key studies: *Lin & Wu (2015); McKinney & Tyler (2018); Pierson & Grapin (2021); Kim & Kim (2024)*

Literature Review
What is Translanguaging?

Beyond Code-Switching and Traditional Bilingual Education

Translanguaging is:

✓Flexible use of all linguistic resources
✓Multiple modes of communication
✓Meaning-making across languages and representations
✓An integrated view of students' full repertoire

Includes:

Speaking and writing

Gestures and body movement

Drawings and diagrams

Models and technology

What it is NOT:

Simply switching between two separate, bounded languages

Separating languages by time or subject (traditional bilingual education)

Key studies: *Pierson & Grapin (2021); Prediger et al. (2019); Tai & Wei (2026)*

Literature Review
Theoretical Perspectives

Four Theoretical Perspectives

Theory	Contribution
Translanguaging Theory	Full linguistic repertoire as a learning resource
Sociocultural Theory	Learning through interaction and participation
Funds of Knowledge	Connecting home and community knowledge
Community of Practice	Learning through participation in classroom communities

Big idea:

Language, culture, and participation are inseparable from STEM learning.

Literature Review
Translanguaging Supports Sense-Making

Translanguaging as a Resource for Learning

- *Students use translanguaging to:*
- *Connect everyday and academic knowledge*
- *Explain ideas and construct understanding*
- *Negotiate meaning*
- *Participate in disciplinary practices*

Key concepts:

✓***Translanguaging spaces*** *– classroom environments where multilingual and multimodal resources are legitimized (Salloum et al., 2025; Guzula et al., 2016; Tai & Wei, 2021a)*

✓***Multimodality*** *– integrating gesture, drawing, models, technology, and body movement (Pierson & Grapin, 2021; Krause & Farsani, 2022; Tai & Wei, 2026)*

✓***Meaning negotiation*** *– clarifying, comparing, revoicing, and co-constructing understanding (Lin & Wu, 2015; Prediger et al., 2019; Tai & Wei, 2021b)*

Translanguaging is not merely support for language learners — it is a mechanism for learning STEM (Pierson & Grapin, 2021; Lin & Wu, 2015).

Literature Review
Mechanisms Supporting Sense-Making

1. Prior Knowledge Activation

Teachers use translanguaging to connect new concepts to students' existing knowledge, home language, cultural resources, and everyday experiences (Salloum et al., 2025; Tai & Wei, 2020; Prediger et al., 2019; Krause et al., 2022).

2. Multimodal Representation

Multiple semiotic resources help students represent ideas that may be difficult to express through words alone (Pierson et al., 2021; Krause & Farsani, 2022; Tai & Wei, 2026; Tai & Wei, 2024; Pun & Tai, 2021).

3. Linguistic Mediation

Translanguaging helps students access technical vocabulary, understand task directions, process disciplinary concepts, and express ideas before fully formulating them in the dominant academic language (Lin & Wu, 2015; López, 2025; Tai, 2022).

4. Collaborative Reasoning

Translanguaging supports collaborative reasoning by allowing students to discuss, question, explain, and justify ideas using the language and representations most available to them (Schüler-Meyer, 2017; Tai & Li, 2025; Pun & Tai, 2021).

These four mechanisms work together, often simultaneously, to support multilingual learners' participation in disciplinary reasoning.

Literature Review
Translanguaging in Mathematics

Translanguaging in Mathematics supports:

- *Conceptual understanding (e.g., fractions across languages)*
- *Problem solving*
- *Explanation and justification*
- *Multiple representations*

Examples from the literature:

Fraction understanding across Turkish and German (Prediger et al., 2019)

Real-life metaphors and cooking examples (Tai & Wei, 2020)

Playful talk and rhyming mnemonics (Tai & Wei, 2021b)

Embodied enactment – physical dramatization of math scenarios (Tai & Wei, 2026)

***Transpositioning** – shifting between roles, languages, and modes (Tai, 2025)*

***Key studies:** Prediger et al. (2019); Schüler-Meyer et al. (2017); Tai & Wei (2020, 2021b, 2024, 2026); Tai (2025)*

Literature Review
Translanguaging in Science

Translanguaging in Science supports:

- *Scientific explanation*
- *Inquiry and argumentation*
- *Modeling*
- *Laboratory participation*

Examples from the literature:

Co-constructing scientific proof using everyday Cantonese (Lin & Wu, 2015)

Refugee science learning through Arabic, English, and family knowledge (Salloum et al., 2025)

Multilingual science assessments (López, 2025)

Laboratory discourse and dialogic co-making of knowing (Pun & Tai, 2021)

Key studies: *Lin & Wu (2015); Pun & Tai (2021); Salloum et al. (2025); Kim & Kim (2024)*

Literature Review
Teacher Practices and Challenges

Effective Teacher Practices

- *Asset-based stance (valuing students' languages and cultures)*
- *Co-learning (positioning self as co-learner, not sole authority)*
- *Multimodal design (integrating gesture, visuals, technology)*
- *Flexible language use*
- *Connecting to students' lived experiences*

Challenges

Category	Specific Barriers
Student	Monolingual beliefs ("I should only use one language"); language identity concerns
Teacher	Limited preparation; uncertainty about implementation
System	English-only assessments; EMI policies; curriculum pressures
Equity risk	Shared-knowledge translanguaging can inadvertently exclude students who do not share cultural references (Tai & Li, 2025)

Literature Review
Research Gaps and Implications

What We Know

✓Translanguaging supports participation and engagement
✓Translanguaging supports STEM sense-making across contexts
✓Translanguaging promotes more equitable learning opportunities

What We Don't Know

❌ *Few longitudinal studies (Aminifar et al., 2024 is a rare exception)*
❌ *Limited quantitative evidence of student learning outcomes*
❌ *Few studies outside Hong Kong secondary contexts (geographic concentration)*
❌ *Few teacher-friendly implementation models*

Key Gap

The literature provides strong principles but limited practical frameworks for adapting mathematics and science instructional routines through a translanguaging lens.

Implication for Future Research

Develop and test practical frameworks that help teachers redesign:

- *Reasoning routines*
- *Argumentation protocols*
- *Disciplinary sense-making activities*

for multilingual STEM classrooms.

From Translanguaging Principles to a Design Framework

From Translanguaging Principles to a Design Framework

Literature provides principles but limited practical guidance for adapting instructional routines and protocols.

Examples from the literature:

Stance–Design–Shifts *(Salloum et al., 2025)*

Co-learning *(Tai & Wei, 2021a)*

Playful Talk *(Tai & Wei, 2021b)*

Multimodal Mediation *(Tai, 2022)*

Disciplinary Translanguaging *(Pierson & Grapin, 2021)*

Drawing on the translanguaging pedagogy framework developed by García, Johnson, and Seltzer (2017), Salloum et al. (2025) conceptualize translanguaging pedagogy through three dimensions Stance–Design–Shifts	
Translanguaging-Informed Design Framework	
Stance	Viewing multilingual repertoires as assets for STEM learning
Design	Prior Knowledge Activation + Multimodal Representation + planned opportunities for Collaborative Reasoning
Shifts	Translanguaging Mediation + responsive facilitation of Collaborative Reasoning

Project Overview: Science and Mathematics Components

Science Focus

- *Implementation of a translanguaging-based vocabulary intervention using multilingual Frayer Models.*
- *Investigation of students' acquisition and application of academic genetics vocabulary.*
- *Data collected through surveys and performance-based assessments.*

Mathematics Focus

- *Development and adaptation of instructional routines and protocols through a translanguaging lens.*
- *Examination of how existing mathematics routines can be redesigned to support multilingual learners' mathematical sense making.*
- *Current work focuses on adapting instructional protocols using principles identified in the literature review.*

Shared Goal

To move beyond viewing language as a barrier and instead position multilingual learners' linguistic, cultural, and semiotic resources as assets for participation, reasoning, and disciplinary learning.

Science Phase

Research Design

Purpose

To examine the impact of a translanguaging-based vocabulary intervention on students' acquisition and application of academic science vocabulary within a genetics unit.

Design

- *Pilot study*
- *Mixed-methods approach*
- *Surveys and performance-based assessments*
- *Grounded in translanguaging theory and multilingual vocabulary development*

Study Structure

Pre-Intervention Survey → Translanguaging Intervention → Post-Intervention Survey → Summative Assessments

Science Methodology

Phase 1: Pre-Intervention Survey

The pre-intervention survey was administered to establish students' baseline understanding of academic science language and current translanguaging practices.

Survey Focus

- *Language background*
- *Current translanguaging practices*
- *Vocabulary confidence*
- *Learning preferences*

Purpose

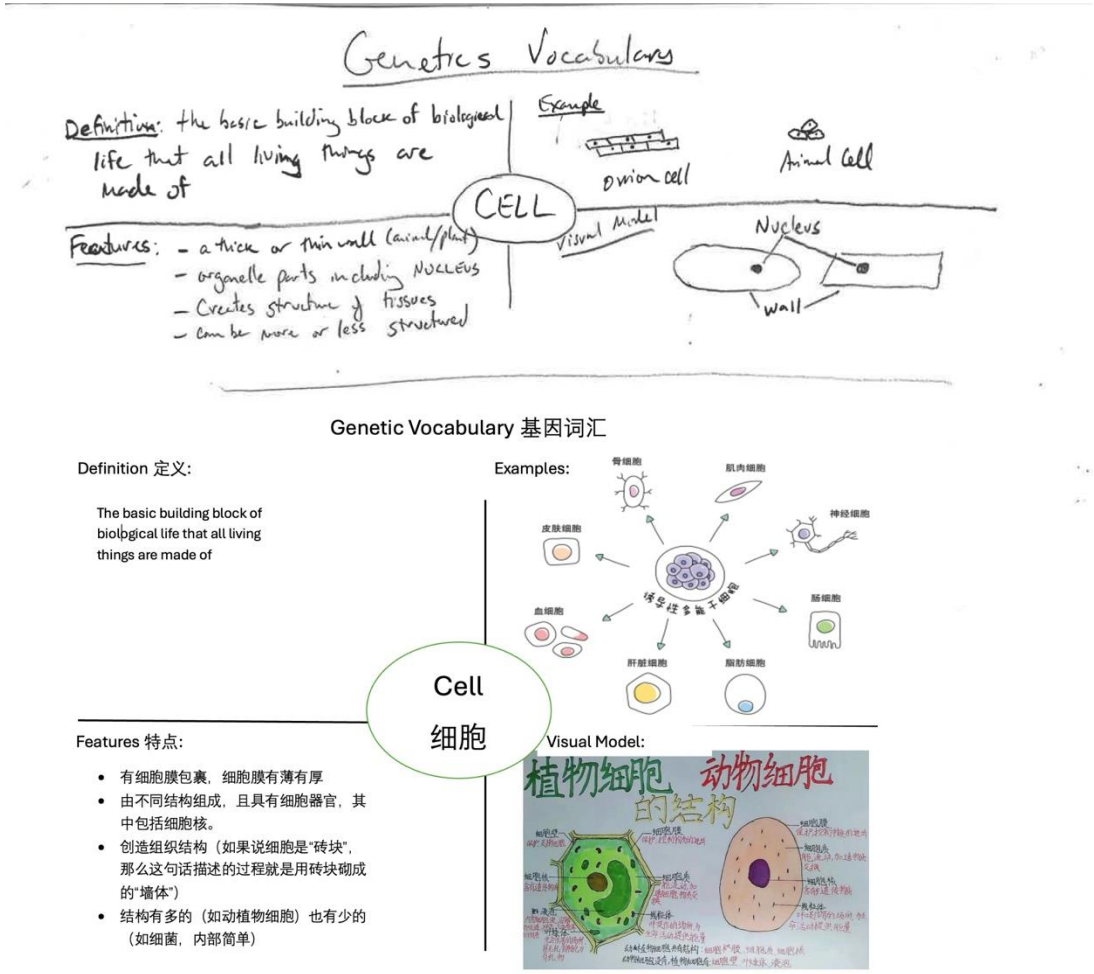
To better understand students' multilingual repertoires and existing approaches to academic vocabulary learning before the intervention.

Science Methodology

Phase 2: Intervention

A translanguaging-based intervention was embedded within a genetics vocabulary sequence.

*The intervention utilized the **Frayer Model** as the primary instructional strategy, allowing students to engage with academic vocabulary through multiple linguistic and representational modalities.*



Science Methodology

Phase 2: Intervention

Students completed Frayer Models that included:

- *Definition (English)*
- *Features (any language(s))*
- *Examples (any language(s))*
- *Visual Model (annotated in any language(s))*

Translanguaging Principles Embedded in the Intervention

- *Multiple language pathways*
- *Multiple representation pathways*
- *Connection to prior knowledge*
- *Student choice and agency*
- *Multimodal meaning-making*

Students were encouraged to draw on their full linguistic repertoires when constructing meaning and communicating understanding.

Science Methodology

Phase 3: Post-Intervention Survey

Following the intervention, students completed a post-survey designed to examine changes in their use of translanguaging and confidence with academic science vocabulary.

Survey Focus

- *Engagement with the intervention*
- *Frequency of language switching*
- *Perceived benefits of translanguaging*
- *Confidence with genetic vocabulary*
- *Preference for multilingual versus English-only approaches*
- *Willingness to use the strategy in future learning*

Purpose
To investigate students' perceptions of the intervention and the role of translanguaging in vocabulary development.

Science Methodology

Phase 4: Summative Assessments

Assessment 1: Genetics Laboratory Report

Students demonstrated their application of target vocabulary through a laboratory investigation.

Required Components

- *Testable research question*
- *Independent, dependent, and control variables*
- *Detailed procedure*
- *Claim-Evidence-Reasoning (CER) conclusion*

Focus
Assessment of vocabulary frequency, accuracy, and contextual appropriateness within authentic scientific writing and reasoning tasks.

Science Methodology

Assessment 2: Concept Transfer Task

- *Students demonstrated conceptual understanding and vocabulary transfer through multiple tasks.*

Component A

- *Synthesize information from two genetics texts*

Component B

- *Create pedigree charts*
- *Construct Punnett Squares*

Component C

Develop a cause-and-effect explanation connecting:

- Parent phenotype
- Offspring genotype
- RTK receptor activity
- Offspring phenotype

Focus

Assessment of students' ability to transfer and apply academic genetics vocabulary within increasingly complex scientific reasoning contexts.

Science Methodology

Data Analysis

Survey Data

Survey responses were analyzed using thematic coding to identify patterns related to:

- *Translanguaging practices*
- *Confidence development*
- *Vocabulary learning strategies*
- *Perceived benefits of multilingual learning*

Assessment Data

- *Assessment artifacts will be analyzed for:*
- *Frequency of target vocabulary use*
- *Accuracy of vocabulary use*
- *Contextual appropriateness*
- *Transfer of vocabulary across tasks*
- *Evidence of disciplinary reasoning*

Science Next Steps

Fall 2026: Science Data Analysis

Data Analysis

- *Analyze pre- and post-survey responses*
- *Identify patterns in students' translanguaging practices*
- *Examine changes in confidence with academic science vocabulary*
- *Analyze student perceptions of the intervention*

Assessment Data

- *Assessment artifacts will be analyzed for:*
- *Frequency of target vocabulary use*
- *Accuracy of vocabulary use*
- *Contextual appropriateness*
- *Transfer of vocabulary across tasks*
- *Evidence of disciplinary reasoning*

Science Next Steps

Winter 2026–2027

Findings and Interpretation

- *Synthesize survey and assessment findings*
- *Identify strengths and limitations of the multilingual Frayer Model approach*
- *Compare findings with themes identified in the literature review*
- *Determine implications for multilingual science instruction*

Spring 2027

Dissemination and Future Directions

- *Develop recommendations for science teachers*
- *Refine the translanguaging vocabulary framework*
- *Share findings with the MLRC community and school stakeholders*
- *Explore opportunities for scaling the intervention to additional science units*

Mathematics Phase

Current Stage of Development

The mathematics component of this project is currently focused on the design and adaptation of instructional routines informed by translanguaging research.

Purpose

To explore how established mathematics instructional routines can be modified to intentionally support multilingual learners' mathematical sense making.

Current Activities

- *Analysis of translanguaging literature in mathematics education*
- *Identification of key translanguaging design principles*
- *Review of existing mathematics instructional routines and protocols*
- *Adaptation of routines to incorporate multilingual and multimodal meaning-making opportunities*

Mathematics Methodology

Examples of Routines we are exploring to Adapt

- *Mathematical Language Routines (MLRs)*
- *Notice and Wonder*
- *Which One Doesn't Belong?*
- *Three Reads*
- *Number Talks*
- *Think-Pair-Share*
- *Reasoning and Discussion Protocols*

Translanguaging Principles Guiding Adaptation

- *Multiple language pathways*
- *Multiple representation pathways*
- *Connections to prior knowledge*
- *Collaborative meaning making*
- *Student agency and participation*
- *Multimodal reasoning and communication*

Status

This work is currently in progress. Prototype routines are being developed and refined based on findings from the literature review and will form the basis for future implementation and investigation.

Mathematics Next Steps

Fall 2026

Mathematics Routine Development

- Adapt mathematics instructional routines using translanguaging principles identified in the literature review
- Develop prototype versions of:
  - Mathematical Language Routines (MLRs)
  - Notice & Wonder
  - Which One Doesn't Belong?
  - Three Reads
  - Discussion and reasoning protocols

Pilot Planning

- *Identify target classes and instructional units*
- *Develop data collection instruments*
- *Finalize observation and reflection protocols*

Mathematics Next Steps

Winter 2026–2027

Pilot Implementation

Implement adapted mathematics routines in selected classrooms

Collect:

- Student work samples
- Teacher reflections
- Classroom observations
- Student feedback

Spring 2027

Analysis and Dissemination

- *Analyze implementation data*
- *Refine the translanguaging routine framework*
- *Develop translanguaging-informed recommendations for mathematics and science teachers*
- *Share findings with the MLRC community and school stakeholders*

Current Status

Component	Status
Literature Review	Complete
Design Framework	Complete
Science Pilot	Implemented
Science Analysis	In Progress
Math Framework	In Development
Math Implementation	Planned

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