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Special Issue(s) in Mathematics Education: Research to Practice

Claudia M. Pagliaro, Ph.D.
Jennifer S. Thom, Ph.D.
(and fellow authors)

NRSC/DeafTEC Math Conference 2022
Rochester Institute of Technology
November 7-9, 2022

CRITICAL TOPICS IN MATHEMATICS EDUCATION: RESEARCH TO PRACTICE WITH DEAF AND HARD OF HEARING LEARNERS

AMERICAN ANNALS OF THE DEAF

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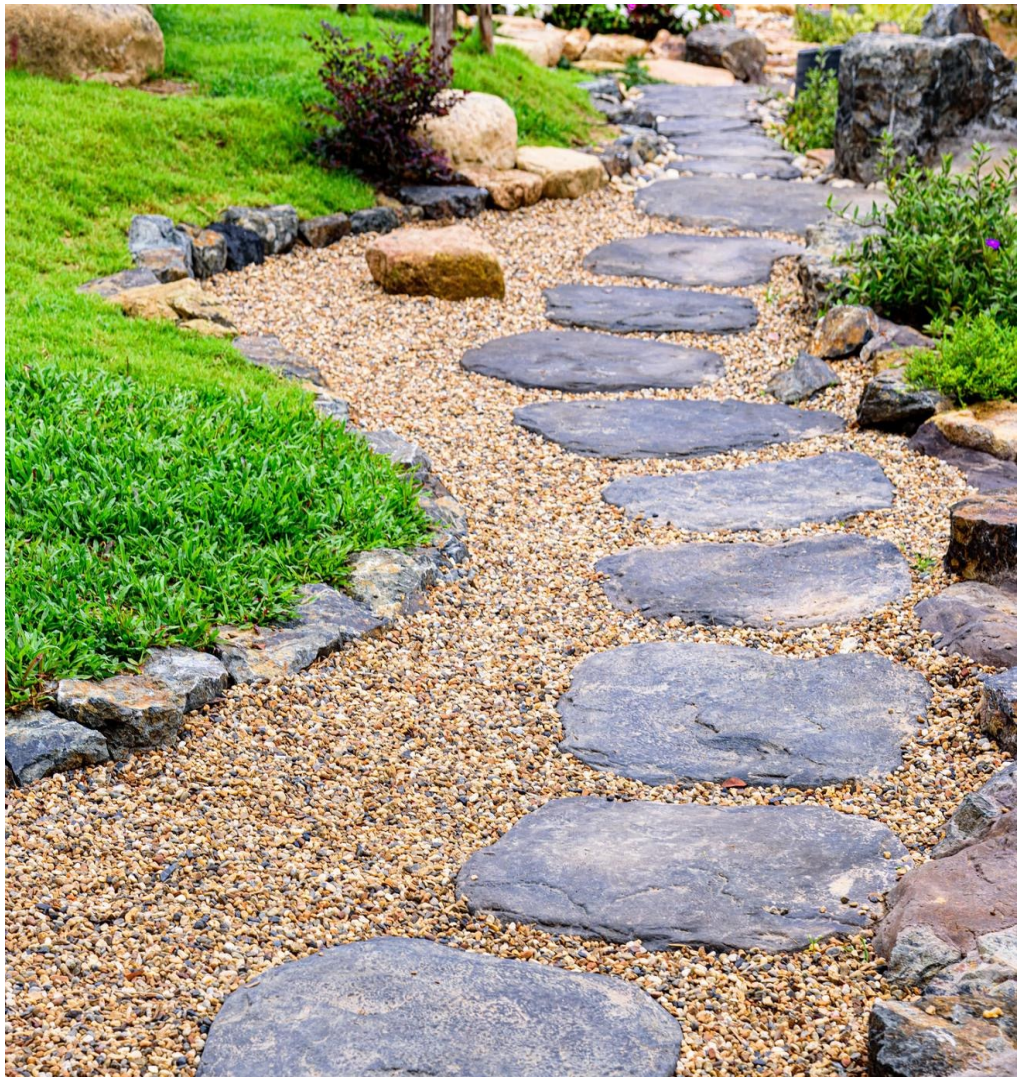
A professional journal dedicated to quality in education and in related services for children and adults who are deaf and hard of hearing

Special Issue, *American Annals of the Deaf, 166* (6), 2020

https://muse.jhu.edu/issue/47311

Steppingstones – past, present, future



- Math – always been here, always will be. ☺
- 1990: Summer Institute at Gallaudet U.
- 1994/95: NAPMERD (National Action Plan for Mathematics Education and Research for the Deaf)
- 2010: Review - previous 25 yrs. of mathematics research
- 2012: Math Meeting of the Minds (M^3)
- 2018-2022: Special Issue
- 20??: Next steps

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AMERICAN ANNALS OF THE DEAF

Authors:

- 10 authors
- Austria, Canada, Germany, U.S.
- D/deaf and hearing
- Deaf education, mathematics education, early childhood education, curriculum studies, and linguistics

Suggested Format

Special Issue – Article Name

Authors

- ❑ Summary
- ❑ Classroom Implications
- ❑ Future Research/Practice

Counting Differently: Assessing Mathematics Achievement of Signing Deaf and Hard of Hearing Children Through a Unique Lens


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Jon Henner, Claudia Pagliaro,
SaraBeth Sullivan, Robert Hoffmeister

Counting Differently:

Assessing Mathematics Achievement of Signing Deaf & Hard of Hearing Children Through a Unique Lens*

Jon Henner
Claudia Pagliaro
SaraBeth Sullivan
Robert Hoffmeister

*Awarded AERA 2022 Early Career Publication Award, Research in Mathematics Education

Rationale

- Decades of achievement studies too simplistic in their views of DHH "behind" hearing peers.
  - Focus on averages that mask complexity and true variability
  - Less attention to demonstrated age-appropriate mathematics skills

- Comprehensive view of student achievement and an exploration of multiple factors that may contribute to mathematics performance

Jon Henner

- Video by Dr. Jon Henner

Research Questions

- 1. How do the mathematics achievement scores of DHH participants compare to the appropriate hearing-normed mean RTI units for the ages?

- 2. What factors (e.g., age, gender, language input [signing status], ASL vocabulary, and learning disability) influence DHH students' performance?

Details

- 257 DHH participants
- 8–18 years
- 32% native signers
- 54% female
- 35% Latinx; 31% Asian American/Pacific Islander; 26% White; 8% Black
- 42% No LD

- ASLAI: American Sign Language Assessment Instrument
- NWEA MAP: Northwest Evaluation Association: Measures of Academic Progress: Mathematics Test

- RTI: Level of difficulty at which correct answer not due to chance
- +/- SD: wider range than typical median score, showing score variability

Results

- Scores for native signers higher than non-native signers
- DHH scores overlapped MAP RTI norms (34% native; 19% non-native)
  - DHH scores met/exceeded hearing scores in every single comparison except one
- Significantly better scores if:
  - Older
  - Native signer
  - More ASL vocabulary
  - Male
  - Non-LD

Implications/Suggestions

- DHH performance determined beyond simple means analysis
- Consider complexities and nuances
  - Measures relative to life experiences of being DHH in a hearing society that makes little allowance for full access to language
  - Measures relative to multiple identities (age, gender/sex, culture, disability, etc.)

- HENCE…
  - Instruction from a positive expectation of DHH student performance that is contextualized, authentic, and meaningful

Pedagogical Suggestions to Foster Fraction Learning

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Keith Mousley

Pedagogical Suggestions to Foster Fraction Learning

Keith Mousley
”Moose”
11/8/2022

Summary

- Some countries are doing well with fractions.
  - Singapore/ Japan (among the countries with highest scores in math) while US ranked 39th among countries
- This led to study Singapore philosophy and Japan philosophy
  - Encourage student engagement and broaden student thinking in relation
    to CPA. (Concrete, Pictorial, Abstract)
- Awareness of the importance of skill building with fractions.
- A lot of exposure to math
- Connectability

Classroom Implications

- Teaching fractions- Using CPA
  - ½ + ¼ = ???? Use pizza, measurement cups, foam noodle
    THEN use diagram of ½ adding to ¼ , Then ½ +1/4 =___
- Trial and Error. This is extremely important

A little harder example:

½ x ¾ = ????

This is where you can talk about it: ½ OF ¾

Use foam noodle…. THEN NUMBER BAR…. THEN ½ x ¾ = _____

Classroom Implications continued……

- Positive interactive conversation
- Feedback with a smile
- A lot of exposure to math..(Minimize the separation of math and world)
- Connectability: any math skills
  - Life examples - recipes, woodworking, making quilts, grocery shopping, budget planning (making plan for trip), looking for a good sale, dinner conversation, etc.

Future ideas to consider:

- Professional Training:
  - CPA
  - Take math courses. (nice refresher)
- Take chances of trying different approaches and share with your colleagues
- Investigate why students make errors while they are doing fraction work. (knowledge gaps, design to address weak areas)
- Need more research on word problems, relationships (ratio, fractions, percentage), and connection between math and languages (ASL and English)

Sign Language in Light of Mathematics Education: An Exploration Within Semiotic and Embodiment Theories of Learning Mathematics

Christina M. Krause

Annika M. Wille

Sign Language in Light of Mathematics Education: An Exploration Within Semiotic and Embodiment Theories of Learning Mathematics

Christina Krause (U of Graz, Austria) & Annika Wille (U of Hannover, Germany)

Motivation from the *perspective of mathematics education:*

→ Modalism in research on aspects of language in learning mathematics

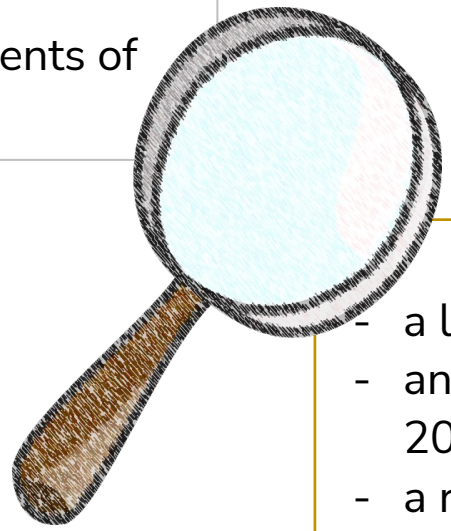
→ Sign languages rarely considered so far

Motivation from the *perspective of Deaf education:*

→ Only little research on learning processes

What‘s the roles of sign languages in mathematical learning processes?

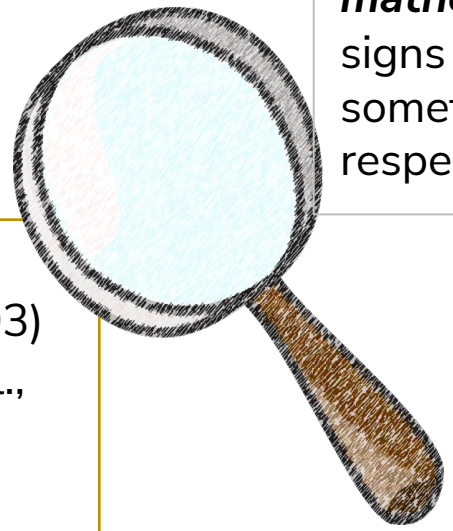
Embodiment lens on learning mathematics: sign languages as embodied enactments of mathematics



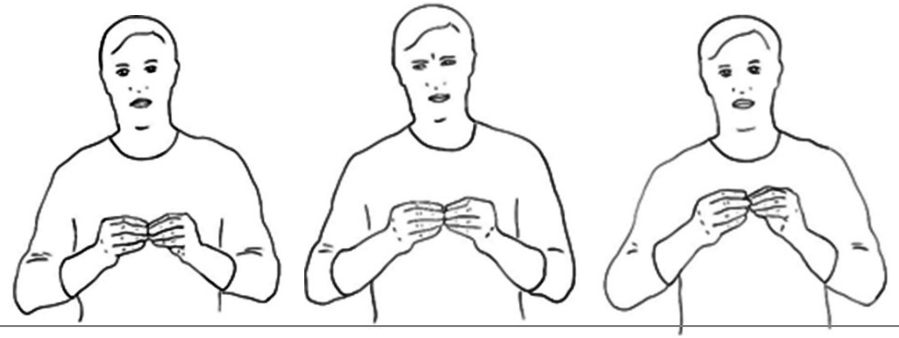
Language

as

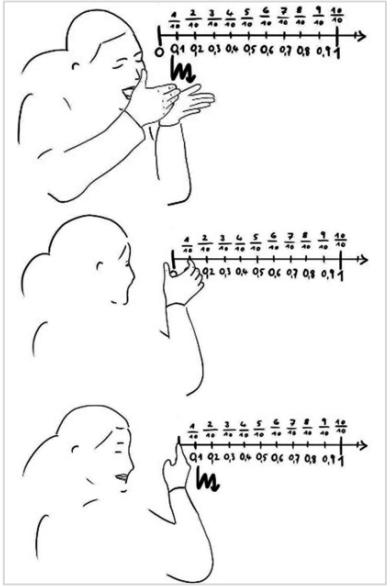
- a learning goal (Lampert & Cobb,, 2003)
- an obstacle for learning (Prediger et al., 2019)
- a resource for learning mathematics (Planas, 2018)



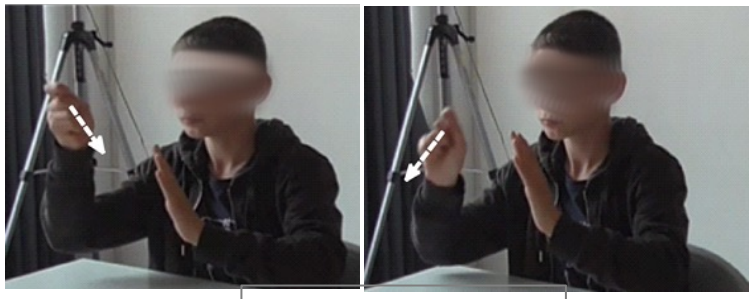
Semiotic lens on learning mathematics: SL signs as ‚standing for something in some respect or capacity‘



Innerlinguistic iconicity / phonologically similar (Krause, 2017) / indexicality (Wille, 2020)



The iconic reference (what the sign resembles) influences, how the concept is understood (Grote, 2010)



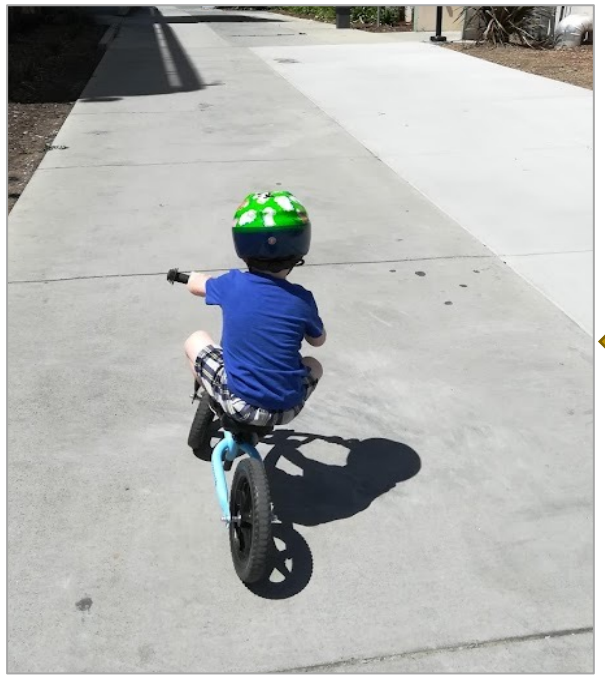
iconic-physical

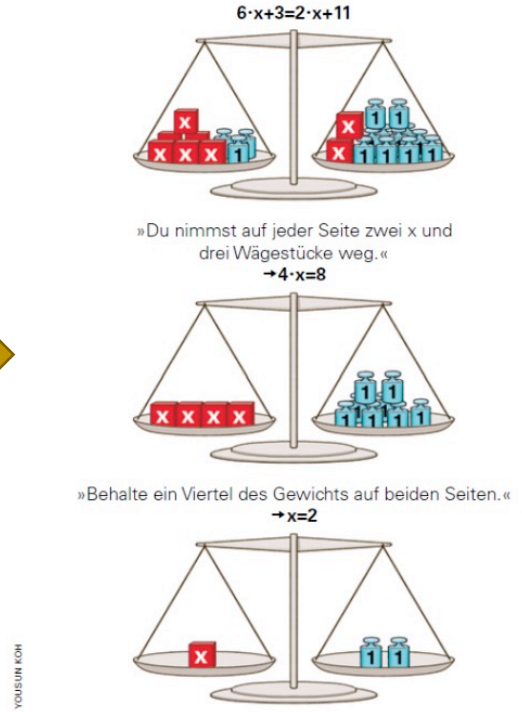
iconic-symbolic

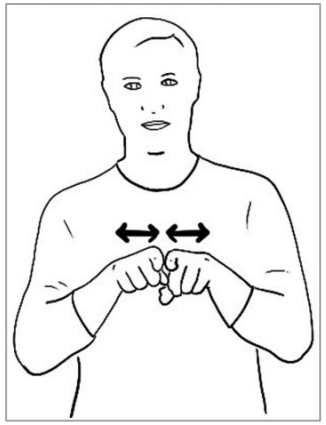
Diagrammatic activity and talking about it as important for learning math (Wittgenstein):
Sign languages allow to combine both

(examples taken from: Krause, 2017, 2019; Krause & Wille 2021)

The embodiment of (mathematical) language?



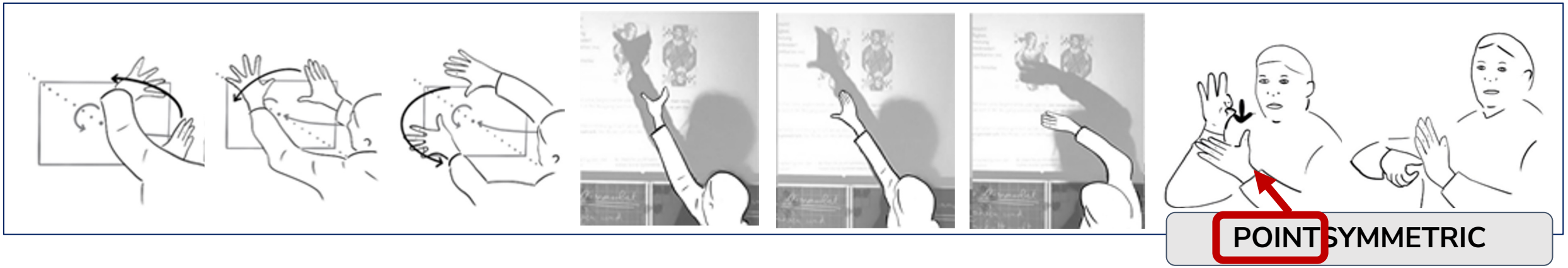




GLEICH (ÖGS)
(*equal*)

Grounding mathematical language in action

ACTION → GESTURE → SIGN



(Krause & Abrahamson, 2021; *in preparation*; Tancredi, Chen, Krause et al., 2021)

Implications for the classroom:

- Sign languages can be a resource for learning mathematics (e.g., Kurz & Pagliaro, 2020) and also an obstacle
- Iconicity of mathematical signs needs to be consciously considered (e.g., Krause, 2017; 2019)
- Mathematical signs can be „charged“ with meaning through actions with and without diagrams (Krause, 2018; 2019)
- Deaf students can lead the negotiation of manual mathematical communication
- Signed videos can become a tool in the mathematics classroom (Wille, 2019 see also https://aslclear.org/app/#/)

Future directions:

→ How can we use the insights on the influence of sign languages on learning mathematics for developing instructional methods and material (e.g., Krause & Abrahamson, 2021)?

Beyond Words/Signs: DHH Learners' Spatial Reasoning in Mathematics as Embodied Cognition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Jennifer S. Thom

Taylor Hallenbeck

BEYOND WORDS/SIGNS

DHH Learners' Spatial Reasoning in Mathematics as Embodied Cognition

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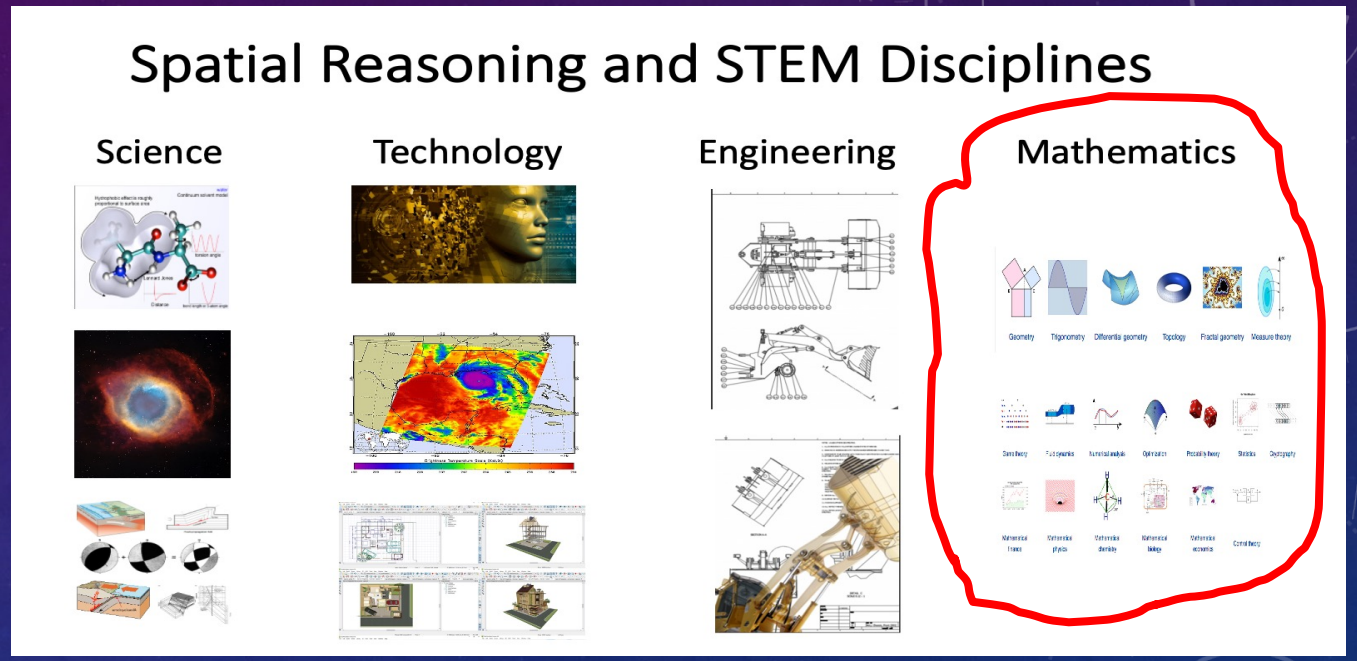
Social Sciences and Humanities Research Council of Canada
Canada
University of Victoria

CONTEXT, IMPETUS, AND FOCUS OF STUDY

Limits career prospects in STEM-related fields AND creates missed opportunity for DHH people to contribute to the advancement and innovation of STEM fields.



"… search into STEM-related … (Thom & Hallenbeck, 2…

Denies teaching-learning opportunities in mathematics education that promote DHH learners' potential to excel, regardless of educational setting.

Spatial reasoning as "the ability to recognize and (mentally) manipulate the spatial properties of objects and the spatial relations among objects" (Bruce et al., 2017, p. 147).

THE STUDY

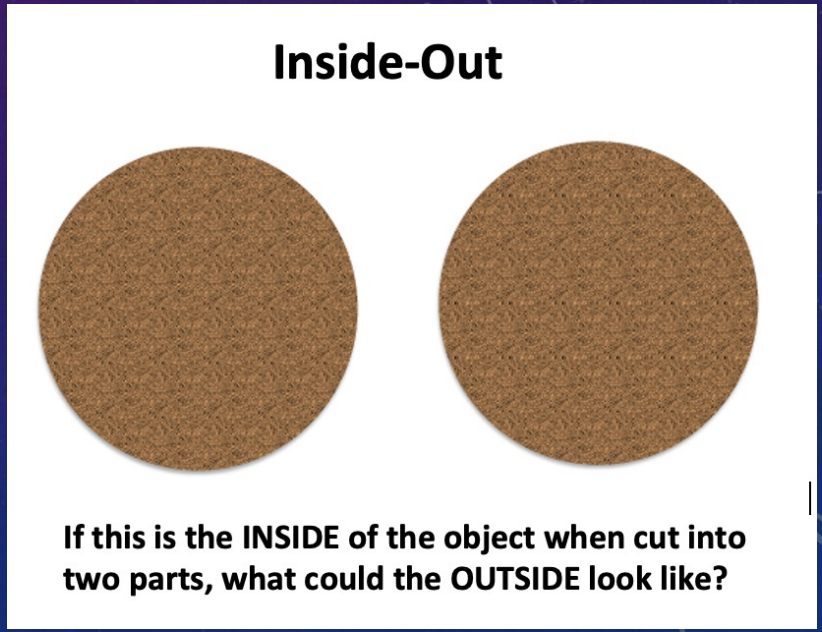
PARTICIPANTS
- Lia and Macy (Grade 1, hard of hearing, SSS)
- Stella (Grade 1, hearing)

SIGNIFICANCE
- First study to explicate the embodiment of spatial reasoning in geometry of young DHH children in mainstream classroom settings (Thom & Hallenbeck, 2021).

THEORETICAL-METHODOLOGICAL FRAMEWORK
- Embodied cognition
- Qualitative case study

FOCUS OF CASE STUDY
- Lia's and Macy's conceptual thinking as it emerged and evolved as culturally *em*bedded and *bodied* phenomena (Gallese & Lakoff, 2005; Marghetis & Núnez, 2013; Varela et al., 1993).

THE GEOMETRIC TASK



FINDINGS

ANALYSIS OF KEY SPATIAL REASONING PROCESSES
(Davis et al., 2015)

- De/re/composing

Figure 8. Macy (Hard of Hearing) Decomposes and Recomposes 3D Objects

Lia Indicates 2D Shape Within a 3D Object

Macy Composing in 2D

Figure 10. Lia (Hard of Hearing) Recomposes a 3D Object

ALSO DEMONSTRATED:
- (Cross)sectioning
- Situating (dimension shifting and locating)
- Interpreting (diagramming, modelling, comparing, and relating)
- Sensating (visualizing, imagining, and tactilizing)

CLASSROOM IMPLICATIONS

SPATIAL REASONING AS:

- A wide range of embodied processes (nonverbal/verbal/signed) that are conceptually dynamic and fluid.
- Tools (Newcombe et al., 2013) that can be used to manipulate, transform, and produce 2D (i.e., circles) and 3D figures (i.e., spheres, cones).
- That with which to communicate and make geometric thinking justify conjectures; and generate conclusions.

FUTURE RESEARCH AND PRACTICE

RESEARCH

- Up-close accounts and analyses of DHH learners' spatial reasoning and its embodiment in geometry.
- Methodologically diverse examinations, including case studies.
- Across mathematics topics, student populations, language/communication systems, and educational settings.
- How sign language use impacts spatial reasoning processes (e.g., Gentner et al., 2013; Hemmler et al., 2017; van Dijik et al., 2013) and how it can positively contribute to DHH children's conceptualization and embodiment of mathematics.

FUTURE PRACTICE

- More than and different from visual (Conway et al., 2011) and hands-on activities (Easterbrooks & Stephenson, 2006).
- Approaches that enable DHH learners' embodiment of geometry (e.g., gesture, drawing, modelling, as well as using one's body).
- Emphasize conceptually meaningful vocabulary development (AASD Accessible Materials Project, 2019; Kurz & Pagliaro, 2020) related to nonverbal/verbal/signed language as perceptually-guided and grounded action (Barsalou, 2008; Gallese & Lakoff, 2005; Pulvermüller & Fadiga, 2010; Varela et al., 1993).

Playing With Code: An Innovative Way to Teach Numeracy and Early Math Concepts to Young DHH Children in the 21st Century

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Editorial

Karen L. Kritzer

Laurie Green

Playing with Code!

Karen L. Kritzer, Ph.D

Director, Deaf Education Program

Kent State University

DeafTEC Math Conference,

Rochester NY

November 2022

Kritzer, K. & Green, L. (2021). **Playing with code: An innovative way to teach numeracy and early math concepts to young DHH children in the 21st century**. In Pagliaro, C. & Thom, J. (Eds.). Topics of Mathematics Education for Deaf and Hard of Hearing Students [Special issue]. *American Annals of the Deaf, 166*(3), 409-423.

Co-Author: Laurie Green
Technology Consultant
Kent State University

Consider two teaching scenarios…

Class A: Student is given a ruler and asked to measure the distance between point A and point B. She does this and returns to her seat.

Which student has learned more?

- **Class B**: Student is given a Code-a-pillar and asked to make it move from point A to point B. She works independently for several minutes gradually becoming more systematic in her measurement. Her teacher wonders “aloud” if she can use her hand as a measurement tool to help. Child discovers that each segment of the Code-a-pillar added causes it to move approximately the length of her hand. She adds one more segment and successfully gets the toy to its destination!

Technology as a Teaching Tool

- Technology-enhanced teaching resources (e.g., Bee-Bot; Code-a-pillar, Kubo) provide coding opportunities that engage young children in learning skills such as problem solving, planning, and organization that are critical for future learning
- “Coding toys” provide kinesthetic experiences to explore early numeracy skills such as counting, addition, subtraction, and estimation in fun ways that are meaningful and purposeful for young children.

All “Coding Toys” are not created equal!

- Your selected device should:
  - be intuitive
  - stand alone (i.e., not require and complicated or expensive extra purchases)
  - come from a company that has been established and is founded on empirically-based research
  - be subject agnostic (i.e., can easily be used across the curriculum)
  - be open ended (i.e., not prescriptive- use limited only by teacher’s creativity)

Examples of Technology Learning Tools

Learning Tool	Description	Company	Mathematical Concepts/Skills
Code-a-pillar	Segmented caterpillar toy in which each segment is marked as a segment of code. Segments are easy to connect and are marked to indicate different types of movement (e.g., straight, turn). Segments can be arranged and rearranged to modify the Code-a-pillar's movement.	Fisher-Price	Experimentation, problem solving, patterns, spatial sense, estimation, sequencing, coding, critical thinking
Bee-Bot	An easy to use, simple, hands-on device. Can be coded to move forward, back, right, or left, allowing students to create codes to problem solve and discover mathematical concepts.	Terrapin Tools for Thinking	Number, estimation, distance, direction, computational thinking, coding, input, output, problem solving, patterns

Successfully solving a problem feels great and makes you a better learner!

- No matter how young or old you are ☺

Special Issue – Connections

1. DHH students are a distinct group of learners, capable of learning and excelling in mathematics when provided with accessible opportunities and appropriate pedagogy.
2. Mathematics instruction with DHH learners should focus on conceptual understanding, not just procedural skills.
3. Language can play an important role in enabling DHH students to understand mathematics deeply, and not serve simply as the conduit for its instruction.


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Special Issue – Suggestions

- Heterogeneity of DHH learners
  - Gender, race, disability, culture, etc.
- Success among DHH learners
- Interventions for DHH learners by DHH community


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Special Issue – Next step

Where *do* we go from here to move the mathematics education of DHH students who we serve, the community of which we are a part, forward in true understanding and progress?

How *do* we work together in:

- research and practice
- birth through college
- in-service and pre-service


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THANKS!!!!!

Math^{power}
The power is exponential!

CRITICAL TOPICS IN MATHEMATICS EDUCATION: RESEARCH TO PRACTICE WITH DEAF AND HARD OF HEARING LEARNERS

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