# Symposium: Embodied Learning in Early Mathematics

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In this symposium we present some of the findings from Phase 1 of a three-phase project (2021-2024) titled *Embodied Learning in Early Mathematics and Science* (ELEMS). The project aims to translate embodied cognition research from the fields of neuroscience, psychology and education into evidence-based classroom teaching strategies, and to produce professional learning materials for teachers. The overall research design for the project is a three-phase structure, guided by design-based research principles and utilising mixed methods of data collection and analysis (Refer to Way & Ginns, 2022 for a project rationale). The underlying premise for the project is that the haptic modes (gesture, touch-tracing, body-movement and drawing) of embodied learning are under-utilised for mathematical representation, and as thinking and communicating tools in the development of mathematical understanding.

Phase 1 of the project involved a year-long collaboration with seven teachers in one NSW school, and their classes of Preschool to Year 2 children. The school has 340 students, with an additional 38 students in an attached preschool. The students come from a diverse range of cultures and 78% of students are from Non-English-Speaking Backgrounds (NESB). The researchers supported the teachers in their explorations of interpreting the research-based key ideas about embodied learning provided by the researchers, into teaching-learning activities for their students. Each of the three papers in this symposium reports a specific aspect selected from the broad range of research outcomes.

Paper 1: Connecting Mathematical Processes and Conceptual Body Movement—Katherin Cartwright & Jennifer Way

Paper 2: Finger Tracing, Noticing Structures and Drawing—Jennifer Way & Katherin Cartwright

Paper 3: Changes in Year 2 Children's Drawings of a Subtraction Story—Jennifer Way & Katherin Cartwright

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The University of Sydney research team: Dr Jennifer Way (Mathematics), Dr Paul Ginns (Educational Psychology), Dr Christine Preston (Science), Dr Amanda Niland (Early Childhood), Dr Jonnell Upton (TESOL), Dr Katherin Cartwright (Mathematics).

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(2023). In B. Reid-O'Connor, E. Prieto-Rodriguez, K. Holmes, & A. Hughes (Eds.), *Weaving mathematics education research from all perspectives*. *Symposium in the proceedings of the 45th annual conference of the Mathematics Education Research Group of Australasia* (pp. 57–69). Newcastle: MERGA.

# *Connecting Mathematical Processes and Conceptual Body Movement*

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Conceptual body movement in education is an external representation mode that research suggests can support children's learning about mathematical phenomena. Children's learning and understanding of mathematical concepts and processes, such as number structure and relationships, number sequencing, position, or geometric properties, may be supported by experiences using their own body movements. The aim of this paper is to share classroom activities trialled within the Embodied Learning in Early Mathematics and Science project in 7 classrooms focusing on conceptual body movements. The results share what was trialled, and what was observed in relation to children's learning of mathematical processes. Findings revealed that body movement is a helpful mode through which young children can learn and communicate mathematical understanding.

Children's use of body movement supports the development of egocentric spatial frames of reference (Dackermann et al., 2017) as they explore the physical environment around them relative to their own perspective. In the context of mathematics, spatial frames of reference are important to model, and then visualise, structural aspects that are mathematically important such as the equal spacing of numbers on a number line, or the conceptual differences in positioning between 'on top', 'under' and 'next to'. *Conceptual* body movement differs from "movements for the sake of movement" (Shoval, 2011, p. 454) that are simply physical in nature, for example, children running on the spot while counting. *Conceptual* body movement involves whole-body movement that is task-specific, where actions relate directly to conceptual understandings. For example, physically jumping forward to model the process of adding-on 3 on a number line. These more purposeful actions Shoval (2011) calls 'mindful movement' and are for "the purpose of learning" (p. 454). Shoval's research highlights that learning can be enhanced when children participate in co-operative action and re-enactment using their bodies in small groups. Garrett et al. (2018) propose that "embodied representations of concepts create pedagogical opportunities to support student learning" (p. 6). The classroom provides an opportunistic space from which to observe these research claims.

During Phase 1 of the ELEMS project, the seven teachers involved in the research at the school were provided with three days of professional learning (PL) across the year. The first PL day focused on the research behind the embodied learning principles (including conceptual body movement) and examples of classroom activities the teachers could trial or adapt. This paper presents a selection of the activities the teachers' trialled or created that embedded conceptual body movement, discusses how they connect to mathematical processes and concepts, and offers ideas about student learning as identified by the teachers during these lessons.

The following questions guided the analysis of these activities: How do teachers incorporate conceptual body movement in mathematics lessons? and What potential mathematical learning connections were identified by teachers when using body movement?

## Approach

The activities were implemented by teachers in Preschool, Kindergarten, Year 1 and Year 2 classrooms. The data related to the activities was either self-reported (by the teachers via the SeeSaw classroom journal, https://web.seesaw.me/, or during post-Phase 1 teacher interviews) or observed by the researchers (during weekly visits to the classrooms where some activities were co-designed by the mentoring researcher and teachers). The selected activities presented in this paper are from the Kindergarten and Year 1 classrooms ($n = 4$ teachers, $n = 77$ students). Activities linked to a range of curriculum areas such as data, position, number sense, patterning, time, and mass, see Table 1.

**Table 1**

*Body Movement Activities Aligned to Mathematical Concepts*

| Number and algebra | Measurement and space | Statistics |
|---|---|---|
| Being the pattern—children used whole body movement to make a 'two pattern'.<br>*Leaping number line*—children stood in place of numbers to act out addition and subtraction number sentences.<br>  <br>*Ten frame hustle*, and *Act it out*—children stood in the frame to make numbers to 10, and to depict addition and subtraction scenarios<br>  <br>Making numbers—children used their bodies to make numbers 1 to 10 on the floor in pairs or groups.<br>*Number track counting*, and *Before and after*—children walk along forwards or backwards<br>  | Being a clock—children represented the numbers around the clock face and two children were the hands<br>  <br>Miming heavier or lighter—children acted out what it might be like carrying something heavy or light.<br>*Stand where?*—children locate themselves in a particular box to match instructions given in relation to left, right, forwards, backwards.<br>  | Being the data—children used whole body to be the data points in a column graph.<br>  |

Titles in *italics* in Table 1 indicate activities that have been refined and are included in the PL package being developed. Some of the activities were explored by the teachers over multiple lessons within a programmed unit of work. Several of the accompanying images within this paper are from when activities were 'recreated' in collaboration with the researchers and teachers as part of the development of the PL package that will be utilised in Phase 2.

# Findings

## *Incorporating Conceptual Body Movement in Mathematics*

Teachers reported in post-Phase 1 interviews that they "used a lot of gesture and a lot of body movement" [Lauren] as they were "the most naturally occurring in our classroom" [Lauren]. Melissa commented that she "did do a lot of body movement … I'm using it as a trigger for things … body movement would trigger–a memory of a learning." Crystal referred to it as "full body movement" in her interview stating it was an opportunity to "just do different activities where their full bodies involved". Of the lessons teachers reported on in SeeSaw, the use of body movement as an embodied learning mode was mentioned the most (in 19 of the 40 lessons). Teachers connected body movement to a wide range of mathematical processes and concepts: "to see how the students could read, describe and interpret results" [Rosa], "to make the patterns using their bodies" [Crystal], "to find the total then move that many steps forward" [Crystal], "to explore ten frames and addition using ourselves as counters" [Melissa], "to be directed to a number and move backwards and forwards" [Rhonda], "to make the numbers 1-4 using our bodies" [Melissa], "to walk like they were heavy or light" [Melissa], "to move with their bodies towards and away from positions including forward, backward, left and right" [Isla], "to create a clock using our bodies [Crystal].

## *Learning Connections Identified by Teachers*

In the interviews, teachers self-identified ways in which connecting mathematical processes to conceptual body movement was impacting their students' learning in positive ways. Rosa reflected that:

> You could just definitely see the improvements in them [the students] … I mean they're kids, to have them sit still for a long time, it doesn't work. So if they are up, using their body, they seem to make that connection.

Teachers provided examples of potential learning connections children made when lessons focused on conceptual body movement. Teachers reported learning gains, where "body movement enabled students to gain a deeper understanding of patterns, that they can be more than just colours repeated" [Crystal], and building children's conceptual development "to understand the concept of being straight and facing the number directly for us to be able to read the time" [Crystal]. Teachers were also able to identify potential misconceptions, "interestingly we had to correct some reversals (a huge focus on class) within body positioning" [Melissa], where assistance was needed, "students needed guidance and support to make the number line round. Spacing was mentioned by a few students" [Crystal], and a shift in confidence, "we used this line to do subtraction as well. Students who don't normally respond to questions were able to confidently answer the questions" [Crystal].

An interesting additional finding was the positive impact the project was having on teachers' pedagogical practice. Melissa reflected on how the project allowed for time to try new practices:

> I mean, we knew there's more than one way, but there's actually more than two ways and more than three ways and that that it doesn't have to be so regimented with the teaching. It gave us a little bit more freedom to experiment with new things. And you know, things like that, doing body movement for maths, is not usually something typically we might tie together, but it kind of opened that scope.

Teachers also reflected on their own understanding and interpretations of the embodied learning principles. Crystal discussed a lesson using number lines:

> Rosa and I went outside to trial a body movement lesson. Students were given a simple equation and had to find the total then move that many steps forward. Students enjoyed moving but we realised this movement was not embodied learning.

## Discussion and Conclusion

Teachers were able to easily incorporate conceptual body movement as a mode of representation into daily classroom lessons. Teachers themselves reported that body movements were one of the embodied learning modes they could repeatedly enact on a regular basis. These activities were an opportunity to identify misconceptions such as number reversals by Melissa, or areas that need further explicit teaching such as number spacing related to clocks mentioned by Crystal. Incorporating body movement was an opportunity to notice conceptual understanding, to assess knowledge, and to build confidence in reluctant speakers as reported by Crystal when exploring equations on the number line. Teachers found ways to weave the embodied learning principles (specifically body movement) into curriculum lessons utilising environmental spaces inside and outside the classroom as well as making use of physical mathematical structures such as number tracks, number lines, ten frames, and grid-structured classroom mats to assist students in developing spatial frames of reference.

Two teachers questioned whether or not the activities they were implementing aligned with conceptual body movement. Crystal's reflection in the number line lesson she and Rosa completed together is evidence of this self-reflection. The students' movement in the positive direction *is* related to the mathematical process of addition, therefore the activity *does* relate to conceptual boy movement. Nonetheless, observing teachers wrestle with the concept of conceptual body movement indicates their attention to making the connections between mathematical process and conceptual body movement correct, and explicit.

Input from the teachers was invaluable in creating and refining the activities to ensure they aligned to age-appropriate classroom practice as well as the theoretical framing of conceptual body movement. Similar to Garrett et al.'s (2018) findings, implementing activities that focused on conceptual body movement, "impacted teachers' pedagogical practices in various ways" (p. 9), where immediate changes were voiced by the teachers themselves. These initial findings may show "significant promise for improving students' learning engagement in mathematics as well as professional renewal for teachers" (p. 16) through the use of embodied learning principles. A future research direction might include observing when/if students use impromptu body movements as a thinking tool about the mathematical concepts, or do they choose to initiate body movements, without prompt by the teacher, as a communication tool.

## References

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