# Active Learning, Collective Participation: From Theory to Practice, Illustrations From Professional Learning About an Embodied Approach to Learning

Katherin Cartwright
*University of Wollongong*
katherinc@uow.edu.au

Jennifer Way
*The University of Sydney*
jennifer.way@sydney.edu.au

Effective professional learning includes the provision of opportunities for teachers to actively engage with learning in a supportive community, where ideas can be shared, trialled, questioned and revised. The professional learning designed within the Embodied Learning in Early Mathematics and Science (ELEMS) Project aimed to assist teachers in making connections between embodied learning research and teaching and learning approaches. Analysis of four online sessions during the project illustrated active learning and collective participation were key for this project's PL and were the most effective features in supporting teachers to implement a new pedagogy.

## Introduction

The implied ultimate goal of effective professional learning (PL) is for improved teacher learning that in turn impacts student learning in a positive way (Beswick et al., 2017). While no set list of 'best practice' features exist to guarantee a successful PL, Desimone and colleagues' own research (Desimone, 2011; Desimone & Garet, 2015; Garet et al., 2001) and review of PL literature (Desimone, 2023) over the past 10–15 years shows that "high-quality learning experiences for teachers, linked to their curriculum and lessons, which provides active learning that includes practice with feedback, can change what teachers do" (p. 2). Five features are listed in Desimone's (2011) paper: 1) content focus–on subject matter and how students learn that content, 2) coherence–with other PL, teacher knowledge and beliefs, and school or state reforms, 3) collective participation–with groups of teachers in the same grade, subject or school to build a learning community, 4) active learning–where teachers have opportunities to be involved in observing, analysing student responses, receiving feedback, making presentations, and 5) duration–where PL activities are spread over a semester and should include 20 hours or more contact time. Desimone and Garet's (2015) paper concluded that "we need more information about specific aspects of the five features that are important in different contexts" (p. 260).

This paper is a window into the ongoing active learning process within the ELEMS project's professional learning episodes. The purpose of this paper is to provide illustrations of Desimone's five features of professional learning that supported productive teacher change. This paper explores the following two research questions:

- How do teachers' reflections and feedback illustrate Desimone's five features of effective teacher professional learning?
- Which, if any, of the features are more important in the context of the ELEMS project?

## Project Background

The ELEMS research project is a synthesis of research findings from the fields of neuroscience, psychology and education indicating that a focus on haptic modes of learning (touch, body movement, gesture, tracing), and on the development of emerging mathematical and scientific drawing, can enhance children's learning by focusing their attention on essential properties, structures and relationships (for example, Alibali & Nathan, 2012; Dackerman et al., 2017). From the analysis of literature (Way & Ginns, 2024) we derived a set of key

(2025). In S. M. Patahuddin, L. Gaunt, D. Harris & K. Tripet (Eds.), *Unlocking minds in mathematics education. Proceedings of the 47th annual conference of the Mathematics Education Research Group of Australasia* (pp. 101–108). Canberra: MERGA.

education principles and proposed the implications for teaching practices in Pre-school to Year 2 (4–8 years old) mathematics and science. In Phase 1 of the project, using a collective approach (Way et al., 2023), seven teachers and their students worked alongside the researchers in trialling and developing embodied learning activities related to mathematical concepts in their classrooms. At the end of Phase 1 the teaching activities were developed into a Teaching Guide, and a professional learning course was developed by the researchers for implementation in Phase 2. The learning goals of the PL in Phase 2 were for teachers to:

- Develop an understanding of embodied learning (gesture, tracing, drawing, body movement) and associated teaching design principles that underpin the ELEMS project.
- Make connections between embodied learning and teaching and learning approaches by reading research and applying knowledge of curriculum.
- Implement teaching practices focused on conceptual development of mathematics concepts in young children as part of the ELEMS research project, trialling lessons and related practices.
- Reflect on continued implementation of embodied learning principles, discussing the impact on teaching practices and students' learning, through group discussions and mini surveys throughout the project.

In Phase 2 four intervention schools received the teacher PL while four control schools did not. Students (n=294) from all eight schools were pre- and post-assessed using the Research-based Early Mathematics Assessment Short-Form (REMA-SF) (Dong et al., 2021). The diagnostic assessment data was collected to determine if there was any significant impact on students' mathematics learning in the schools where the embodied approach was implemented. Analysis received on REMA data across two timepoints (6 months apart) indicated greater learning gains for students in the intervention schools compared with the control schools.

The ELEMS research project had a design-based approach as the methodological framework. A design-based approach is focused on linking theory to practice (Reimann, 2010) and situates the research, and researchers, 'in the field'. Collaboration among researchers and practitioners is key to "make learning research more relevant for classroom practices" (Reimann, 2010, p. 37). The interactive, iterative and flexible characteristics of design-based research allowed the ELEMS project researchers to develop an embodied approach to teaching mathematics in contextually appropriate ways with participating schools.

## Method

In Phase 2, 22 teachers from four intervention schools participated in the ELEMS project and attended 11 hours of PL. The teachers were teaching classes from Preschool to Year 2 (4–8 years old). The four schools varied in contexts including their levels of socio-economic advantage, percentage of students with English as an Additional Language or Dialect (EAL/D), three were metropolitan schools and one was a regional school in NSW, the regional school also had a high percentage of Aboriginal or Torres Strait Islander students.

For the analysis within this paper, a deductive approach was taken where Desimone's (2011; 2023) five features of effective PL were used as a lens to view the feedback and reflection conversations that were embedded with the ELEMS PL episodes. Table 1 presents an overview description of the ELEMS PL course and how each episode aligns with Desimone's features.

**Table 1**

*Overview of ELEMS PL Program*

| Episode | Purpose and/or main activity | Very broadly, teachers will do the following | Alignment to Desimone's (2011; 2023) key features |
|---|---|---|---|
| Episode 1<br>Face to Face<br>(5 hrs) | A whole day introduction to the PL program, embodied learning and the resources available to them | Understand the research base for using embodied approaches, EYLF/syllabus-linked mathematics activity examples, begin planning to integrate embodied learning into teaching programs. | *Content focus, Coherence, Active learning, Collective participation* |
| Implementation phase 1 | Begin implementation of embodied learning approaches. | Access the support resources, try embodied approaches with their classes. Make a brief record of what they have tried and complete the assigned reading. | *Duration, Collective participation* |
| Episode 2<br>Online live<br>(2 hrs) | Deepen understanding of embodied learning practices, focus on relationships between embodied modes and mathematical representations | Increase understanding of the application of embodied learning research, children's mathematical activity and their own teaching practice | *Content focus, Coherence, Active learning, Collective participation* |
| Implementation phase 2 | Continue implementation … | As at Implementation phase 1 | *Duration, Collective participation* |
| Episode 3<br>Online live<br>(1 hr) | Guided reflection, feedback and planning support | Present a brief report of their teaching experiments and contribute to discussions | *Active learning, Collective participation* |
| Implementation phase 3 | Continue implementation … | As at Implementation phase 1 and 2 | *Duration, Collective participation* |
| Episode 4<br>Online live<br>(2 hrs) | Deepen understanding of embodied learning practices with focus on student responses | Contribute examples of student responses, reflect on input, discussions and feedback | *Content focus, Coherence, Active learning, Collective participation* |
| Implementation phase 4 | Continue implementation … | As at Implementation phase 1, 2, and 3 | *Duration, Collective participation* |
| Episode 5<br>Online live<br>(1 hr) | Guided reflection, feedback and planning support | Present a brief report of their teaching experiments and contribute to discussions | *Active learning, Collective participation* |

The teacher presentation sections of Episodes 2, 3, 4 and 5 are the focus for this paper. One of the objectives during these episodes was for teachers from each school to provide the researchers with feedback, reporting on and discussing embodied learning principles trialled in their classroom, sharing student work samples, providing anecdotal observations, and evaluating what further support they need for planning. Teachers were also encouraged to ask questions of the other teachers in different schools and to make connections to their own experiences during implementation. These episodes were conducted via Zoom after school and were video/audio recorded and later transcribed. The transcripts were analysed, and teacher quotations were coded to Desimone's five features. Quotations were selected that illustrated either productive teacher change, or how the teachers' experiences in the project were

influencing or impacting student learning. This paper presents a small set of examples from the larger data across the online episodes that align with Desimone's five features.

## Findings and Discussion

The findings are organised using Desimone's (2011) five features of effective PL. Some descriptions are also drawn from Desimone's (2023) rethinking of teacher professional development paper. For teacher quotes, the episode number and school code [IS# Interventional School number] are used as deidentified labels, any names provided are pseudonyms.

### Content Focus

Desimone (2011) states that "professional development activities should focus on subject matter content and how students learn that content" (p. 69). Within the ELEMS project, this relates to *the what* of the PL, where the content is either the subject matter content i.e., mathematics, or how students learn i.e., through embodied learning approaches.

Teachers talked about the mathematical content they were teaching in their classrooms using embodied modes such as gesture:

> I definitely see as soon as you move your hands and you start to represent with your fingers, they mimic, you can see their minds are automatically engaging, they're looking at their hands and then associating the number of the words with what they see. And I think that's quite magical because that means they're really, they're wanting to understand those concepts. [Episode 3, IS2 and IS1]

> I remember doing a lesson in one of the year 2 classes on arrays that it was about rows and columns and just teaching them the words vertical and horizontal to link with it and the hand gestures, they were able to get that 'vertical' and then 'horizontal' [gestures in Zoom]. [Episode 2 IS4, IS3]

> The concept of counting, like your fingers, we're counting our marks but then there was a line across, and that idea that becomes a bundle of five, and it moved into a different area, and I could see that they were suddenly not disengaged but they were thinking. [Episode 3, IS2 and IS1]

Teachers likewise spoke about *how* students were learning–their confidence–when they implemented an embodied approach in lessons:

> When you do the acting out of subtraction or addition number sentences, I think that's really good for conversations, and when they have to negotiate with each other what they're going to do to depict a number sentence or a word problem, I think that's really useful for them. [Episode 5, IS3, IS1]

> Students started to ask to complete the activities more frequently and longer. I noticed that students, when they would come in, sometimes they go, oh, we're going be doing, 'be a dot' today? Like they were asking for the activity. [Episode 5, IS4]

> I noticed that students' confidence grew dramatically. They were willing to take more risks with their learning. They started linking mathematics into their real life and were supportive of each other. [Episode 5, IS4]

> I could see the kids who are in second grade, and don't really have a sense of the backwards number sequence, … I think oh my goodness if this had begun for that student earlier maybe that would have been a way … they get it [Episode 5, IS2]

Several conversations in the episodes included teachers sharing how the embodied approach was supportive of students from diverse backgrounds and with different needs:

> Neurodiverse kids can find it a barrier, quite difficult, to get up, … in front of the others rather than in a group where not everyone's looking … I think that reminds us that we need a variety of ways to engage with ideas and ways to communicate because it isn't going to suit everybody all the time … They might find it really silly for small concepts, but as the concepts get more complex, they're going to see that it's a really useful tool. [Episode 4, all schools]

> Especially with our context of the children at our school. They find it really hard to listen into people, you have to get them engaged in the learning, that's something that I've noticed [Episode 5, IS4]

When teachers reported back about the *content focus*, reflections almost always included the students, their engagement and/or eagerness to learn through embodied approaches. This

finding leads us to question whether Desimone's (2011) feature label of *content focus* fully captures this feature. Teachers reflected how students enjoyed working with their peers in more collaborative ways when haptic modes such as body movement were the focus of how the students were learning mathematics. The embodied approach was reported as being a differentiation and a communication tool, providing various ways students could show their understanding. The embodied approach was viewed as another way to scaffold learning for EAL/D students and provided an inclusive environment for learning to occur such as for neurodiverse students as mentioned in Episode 4. Teacher comments suggest that the PL supported "teachers in adapting the new ideas and practices for students who may not yet have had the opportunity to develop their foundational knowledge, who may not be native language speakers, and/or who may have special learning needs" (Desimone, 2023, p.2).

## Coherence

The inclusion of coherence means "what teachers learn in any professional development activity should be consistent with other professional development, with their knowledge and beliefs, and with school, district, and state reforms and policies" (Desimone, 2011, p. 69). Coherence as a feature of PL ensures teachers can make connections from the new pedagogy or practice to their current thinking and teaching. In the ELEMS project, this relates to *the why* of the PL, the value and purpose of the approach.

Teachers reported on how the PL content was consistent with their current lesson approaches, curriculum or programs:

> As I mentioned previously, the activities were easily, easy to fit into the units, and already planned lessons, and then seeing them use their mathematical language. [Episode 5, IS4]
>
> I already had implemented touch tracing into my activities … how to write numbers, form letters … So that was already implemented into my curriculum, like my program, before I even started implementing the maths embodied learning. [Episode 5, IS4]
>
> It tends to kind of fall into the structure of how our lessons go, that the embodied part is in the beginning of the lesson where they're trying to understand, like connect to the concept that we're doing. [Episode 4, all schools]
>
> Sometimes when the activity from the DOE unit was too complex for the students or they needed just a bit more solidifying of that context, I'd always go back, and we just keep on doing the activities that were like in the embodied learning teaching guide. [Episode 5, IS4]

The embodied learning activities were easy to implement according to teachers, aligning to Desimone's (2023) reflection that the complexity of the learning matters. Teachers will use new strategies if they are "easier to learn and implement" (p. 2). The embodied learning activities aligned with teachers' current teaching programs and to the structure of their lessons.

## Active Learning

Desimone (2011) suggests that "teachers should have opportunities to get involved, such as observing and receiving feedback, analysing student work, or making presentations, as opposed to passively sitting through lectures" (p. 69). The provision of active learning opportunities for teachers is important during PL so they can ask questions, share experiences, get feedback and practice new approaches (Desimone, 2023). Active learning was an overarching design element of the ELEMS project that guided the delivery, *the how* of the PL allowing space for changes made mid-project based on participant feedback.

The following interaction from Episode 3 is an example of asking questions of each other as *active learning* between teachers of the same grade:

> Researcher: Is there anything that you want to ask the [IS3] teachers, for example?
>
> IS4 Teacher: For the preschool teacher, I noticed that you were saying that a lot of it was in circle time and drawing on whiteboards. Did you take any of it outside into your environment?

> IS3 Teacher: Yes, we do in the sand pit, we would draw symbols, as in the Aboriginal custodian culture.
>
> IS4 Teacher: You'd use the eight ways symbols? Or would you use [symbols of the] Darug people?
>
> IS3 Teacher: We're on Darug land, so we use their symbols

Another interaction from Episode 3, is an example of teachers asking questions of each other as *active learning* about how they are implementing embodied modes:

> IS4 Teacher: Can I ask the IS3 another question? Cause [sic] I like it when I hear buzzwords, and I heard a number of people talk about consistent use. So can I clarify? Do you mean consistent use of the same gesture or just consistent use of like gesture or tracing or body movement at all over regularity in your classroom? If you could expand on that anyone from IS3?
>
> IS3: It was the mode. So if I used a body movement, I'd use that for every warm-up I agree. That week, you know, four times, probably four times, I'd say, that week. That was consistent. In my eyes, that would be consistent. Yeah, so use that mode for the same thing activity.

Teachers also presented what was occurring in their classrooms, how they were embedding embodied learning into the teaching and learning cycle and linking it to research:

> I think it was the article that we read that, you're not just looking for the answer, it's really hard to assess where children are at when you're just looking at pieces of paper and answers to equations, whereas when they're actually doing this embodied learning, it's far more insightful. [Episode 4, all schools]

Although teachers did not specifically comment on the delivery structure of the PL, it was clear from their interactions in each episode that they enjoyed asking teachers from another school questions about how they were implementing the tasks, to develop shared experiences and receive feedback on new practices. The researchers use of prompts within the PL episodes contributed to fostering active learning, which illustrates Desimone's (2023) note that effective PL requires "instructional leaders who are experienced and have relevant content-area expertise and know how to calibrate learning to the teachers' needs" (p.2).

## Collective Participation

According to Desimone (2011), collective participation means "groups of teachers from the same grade, subject, or school should participate in professional development activities together to build an interactive learning community" (p. 69). Collective participation in the ELEMS project relates to *how* the PL is experienced by the participants.

Teachers discussed their own learning experiences with colleagues:

> You know, we're all teachers in the classroom. I need the kids. They're not just learners, they need to be there to help others and teach others, and we're all in this together. It's a journey that we're all on. [Episode 4, all schools]
>
> Teacher 1 IS1: Can I dob someone in? Tanya's gonna [sic] kill me. Tanya was talking about how she uses it for assessment.
>
> Teacher 2 IS1: Yeah, I just said it was a useful tool for assessing where the children are at. You get a really good idea. You know, what we're noticing is, while the children are engaging in embodied activities, I'm thinking it's different. It gives us different opportunities to what we might have in more traditional style activities. [Episode 4, all schools]
>
> What I did mostly, we planned together. [Episode 5, IS4]
>
> The collegial discussion that came with these guys as a team, pre-doing it and then post-doing it has for me, led to a lot more beneficial discussions on where these guys can go … there was that whole collegial discussion that these guys got that they don't get when you do it one-on-one. [Episode 3, IS4, IS3]

Collegiality and collaborative planning were specific features of *collective partition* that were valued by the participating teachers. Schools had formed learning communities, teachers shared what their colleagues were doing well, indicating that ongoing local conversations were occurring between the structured PL episodes.

### Duration

The ELEMS project's PL episode structure supported the provision of sufficient time for teachers to engage with their learning, to then trial suggested activities, and integrate an embodied learning approach into their instructional routines (Desimone, 2023).

Teachers reflected on the duration of the PL and the impact an embodied learning approach was having on their students:

> I feel as though, if I had another run at it, I'd probably do, I'd be recording that I did it in more lessons per week. But I'd be interested, I'm going to be very interested to see how many lessons a week has the impact. [Episode 5, IS2]

> I also think that it's something that probably comes with time. The more confident the teacher is, the more it's part of their everyday practice, the more the kids are used to doing it, then it will become that natural progression …But because I guess for the purposes of what we're doing, there's almost not that length of time needed for that transformation to become apparent. But I think it probably would naturally, because it's a great thing to do. [Episode 4, all schools]

While the teacher participants' engagement with the ELEMS project was for an extended amount of time, over 6 months. We note that, there was not a high-level of contact with the teachers. The PL included one full day of face-to-face PL for 5 hours, then two 2-hour Zoom, and two 1-hour zoom episodes, totalling 11 hours, not Desimone's (2011) recommended "20 hours or more of contact time" (p. 69). However, the ELEMS project PL included high levels of active learning, coherence and collective participation.

## Conclusion and Implications

Evidence that supports Desimone's five key features was identified from the analysis of teacher feedback about implementing an embodied learning approach in classrooms, most commonly *active learning*, *collective participation* and *coherence*. For *coherence*, teachers found the activities easy to implement and aligned with their own current pedagogy and practice. Comments reflected that embodied learning approaches were beneficial for student learning, and that teachers were likely to continue with their newly developed teaching practices. Teachers seeing an embodied approach as 'easy' was an unexpected, yet exciting, observation. When asking teachers to implement a 'new' researched pedagogy, push back and challenges were expected, yet the opposite was communicated in teacher conversation. We attribute this to the *collective participation* of the PL design where during the Zoom sessions teachers were not passive but active participants, eager to hear how others were implementing the approach. The *active learning* element of the PL afforded teachers time to 'notice' practices teachers in other schools were implementing – questioning and clarifying their understanding of the embodied approach. Two of Desimone's features could be expanded on or reconsidered when designing future PL programs–*content focus* and *duration*. Teachers' responses included reference to the mathematical *content focus*, for example, arrays and counting. However, we observed that most teacher reflections did not refer to the mathematics alone but also referred to student engagement and learning of the content. We suggest that Desimone's *content focus* feature might be better labelled as '*content learning focus'*. Renaming this feature would align more to Desimone's (2023) definition that is inclusive of *how* content is learned by students, this change would also broadly include 'teacher' content learning – which is a principal objective of teacher PL. Teachers also acknowledged that time, a *duration* of time, was needed to embed the approach into 'everyday practice'. The length of time, *duration*, however, did not appear to be as important as how the PL time was structured, or used. While our PL did not meet Desimone's benchmark of 20 hours, the structure of the ELEMS PL as a continued, reflective learning community may have mitigated this feature. Future replication of this PL, or any PL, needs to question – can, or how can, high-quality shorter PL still be effective? Part of Phase 3 of the ELEMS project developed the PL into an online format. During development it

was imperative that a key feature of the online PL include sharing of 'the learning journey' both within- and across-schools by participating teachers implementing embodied learning in their own classrooms. Our second research question sought to identify the PL features that appeared to be more important. The interplay between an *active learning* structured PL where *collective participation* was encouraged, was most beneficial for teachers. This was evident through the high level of conversation participation, teacher-to-teacher questioning during the Zoom sessions. Future PL programs should therefore consider *active learning* and *collective participation* as essential, particularly as the prevalence of online PL increases where these features are often lost. *Active learning* merged with *collective participation* when teachers shared individually about their own classrooms but spoke using 'we' in reference to their school team, 'it's a journey that we're all on'. The *collective participation* teachers experienced was valued more so than the amount of time, *duration*, "because I guess for the purposes of what we're doing, there's almost not that length of time needed for that transformation to become apparent … because it's a great thing to do [Episode 4, all schools]".

## Acknowledgements

The ELEMS project is funded by the NSW Department of Education, Strategic Research Fund (2021–2024). 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). Ethics approval 2023/040 was granted by The University of Sydney, and participants gave informed consent.

## References

Alibali, M., & Nathan, M. (2012). Embodiment in mathematics teaching and learning: Evidence from learners' and teachers' gestures. *Journal of Learning Sciences, 21*(2), 247-286. https://doi.org/10.1080/10508406.2011.611446

Beswick, K., Fraser, S., & Crowley, S. (2017). The best ever: Mathematics teachers' perceptions of quality professional learning. In B. Kaur,W. K. Ho, T. L. Toh, & B.H. Choy (Eds.), *Proceedings of the 41st conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 169–176). PME.

Dackermann, T., Fischer, U., Nuerk, H.C., & Cress, U. (2017). Applying embodied cognition: From useful interventions and their theoretical underpinnings to practical applications. *ZDM Mathematics Education, 49*(4), 545-557. https://doi.org/10.1007/s11858-017-0850-z

Desimone, L. M. (2011). A primer on effective professional development. *Phi delta kappan, 92*(6), 68-71. https://doi.org/10.1177/003172171109200616

Desimone, L. M. (2023). Rethinking teacher PD: A focus on how to improve student learning. *Professional Development in Education, 49*(1), 1–3. https://doi.org/10.1080/19415257.2023.2162746

Desimone, L. M., & Garet, M. S. (2015). Best practices in teacher's professional development in the United States. *Psychology, Society, & Education.*, 7, 252 – 263. https://www.mendeley.com/catalogue/ffad80f0-2802-3cc9-9cf8-5e886ed8e992/

Dong, Y., Clements, D. H., Day-Hess, C. A., Sarama, J., & Dumas, D. (2021). Measuring early childhood mathematical cognition: Validating and equating two forms of the research-based early mathematics assessment. *Journal of Psychoeducational Assessment*, *39*(8), 983-998. https://doi.org/10.1177/07342829211037195

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945. https://doi.org/10.3102/00028312038004915

Reimann, P. (2010). Design-based research. In L. Markauskaite, P. Freebody & J. Irwin (Eds.), *Methodological Choices and Research Designs for Educational and Social Change: Linking Scholarship, Policy and Practice* (pp. 37–50). Springer.

Way, J., Cartwright, K., & Ginns, P. (2023, July). A collective approach to embodied learning in early years mathematics (ELEMS Phase 1). In *Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13)* (No. 17). Alfréd Rényi Institute of Mathematics; ERME.

Way, J., & Ginns, P. (2024). Embodied learning in early mathematics education: Translating research into principles to inform teaching. *Education Sciences, 14*, 696. https://doi.org/10.3390/educsci14070696