18 Conclusions

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Having explored the authors' 4E(+) perspectives on learning through examples from the classroom and beyond, we can now reflect on what this means for teachers and teacher students more concretely. What are the implications for theory and practice that emerge? At first, this might be somewhat diffuse, as there are no straightforward action plans drawn out, no tables or clear instructions to paste on the classroom wall. Instead, the learning possible through this book still needs to be processed by you, the reader.

When you think about your own practice—how you prepare the students and the learning materials for your subject(s)—do you already involve aspects of the students' embodied learning experiences? Do your students have a possibility to engage with learning materials in a multimodal way; are they able to connect to the context of the subject matter; are they able to approach matters through active engagements and interactions? Now consider, are there ways in your practice that could improve the situatedness (Brown et al., 1989) of the students and consider their embodied participation more concretely—for example, through exercises that involve whole-body participation or through tangible means for scaffolding learning, such as using material extensions and building blocks?

In this book, we have shown how language learning, reading, and writing are abilities grounded in active and situated participation in and through the social and material world. The very notion of language is body-based (Chapter 2, Kokkola), and words and concepts may be traced back to human-environment interactions and spatio-temporal experiences such as "moving forward" as a way of expressing futures or being "down" as a way of expressing sadness. Words and concepts are our direct channels for meaning-making and communication, and thus also our ways of expressing emotions, to the point that words are even felt in our bodies (Lakoff & Johnson, 1980; Chapter 2, Kokkola). Such metaphors reveal that abstract ideas are deeply grounded in our experiences of the world through the senses.

Through language, we also embody cultures and ways of thinking about ourselves and others. Therefore, acknowledging the embodied nature of language learning is important both in native language education and in learning

a new language. Studies of how languages emerged and how children learn languages emphasise the role of the whole body in meaning-making through language; separating words and grammatical forms from their embedded, enacted contexts lowers children's chances of making sense of them (Chapter 2, Kokkola). As even abstract language is grounded in the body, using gestures that draw on these connections helps children learn more efficiently.

Language learning does not just mean learning a new language or the command of grammar and vocabulary but also includes the process of developing, elaborating, and refining language as a personal means of expression (Chapter 4, von Bonsdorff & Marjomäki). Speaking a language is a way of being in the world, and bodily gestures play a fundamental role in this. When pupils experience difficulty in language acquisition or speaking, this experience may be daunting and affect the pupil's identity in a negative way. Holistic and engaging forms of education are important to boost children struggling with their language production, helping them find alternative ways of expression. Aesthetically supported, playful, and expressive modes of education may prompt spontaneous and self-motivated agency in pupils. Letting them perform as experts and narrators utilising gestures and images may help strengthen their linguistic competencies and self-esteem (Chapter 4, von Bonsdorff & Marjomäki).

Contrary to what is commonly thought, reading is not the mere internalisation and processing of text that we might have come to think of it as. In this book, we have shown that reading is a highly embodied, multisensory, material, and situated interaction between the reader and the sociocultural and material content of the read text that draws on previously experienced bodily interactions in our own lives and extends beyond into the imaginary (Chapter 5, Bro Trasmundi & Mangen). The materiality of reading and forms of writing also has consequences for how the learner experiences and remembers the content (Chapter 6, Korte & Körkkö). Reading is always intimately connected with, and shaped by, the technologies we use when we read (Chapter 5, Bro Trasmundi & Mangen).

The physical and psychological conditions of the reading environment are equally important for the possibility of engaging in deep and concentrated long-form reading experiences. For this to be realised in a school environment, it is necessary for teachers to consider both the embodiment and embeddedness of the reading situation—including the environmental framework, social interaction in the class, the teacher's behaviour, and, ideally, the individual pupil's reader identity and reader history (Chapter 7, Hauer). A calm, comfortable, and clearly defined reading environment, with a supportive teacher, offers pupils the best possibilities to concentrate and absorb themselves in the text and creates the best conditions for focused deep reading, as well as a pleasant reading experience (Chapter 7, Hauer).

This means becoming aware of possibly "hidden" or unidentified aspects in the classroom environment that either hinder or facilitate the reading experience. Often, the expectation of reading is laden with many restrictive

conventions, such as that reading should only happen in complete silence and without moving one's body or interacting with the content through reading aloud or by fiddling with the material aspects of the reading substrate (Chapter 8, Toro & Bro Trasmundi). When students are asked to read aloud, teachers might emphasise the importance of speed, flow, and accuracy over other aspects, such as interpretation or imagination. For students, this can be counteractive, and if the teachers show through their unappreciative bodily communication and (even unconscious) microaggressions that the student's behaviour is wrong, it might further lead to deterring students from wanting to read, even in their free time (Chapter 8, Toro & Bro Trasmundi). An embodied model of reading that allows open-ended processes of bodily engagement—such as creativity, imagination, and critical thinking—along with breaks, sounds, and movements might relax attitudes towards reading, hopefully thus engaging more young readers.

There are ways to engage with literature that considers the embodied aspects (Wilson, 2002)—for example, reading aloud is particularly well-suited to introduce preschoolers to the syntactic and semantic dimensions of language, the tactile materiality of books, and the imaginary worlds of narratives (Chapter 3, Schilhab et al.). The embodied cognition approach indicates that competent language use in conversations and reading emerges from first-person experiences with previously lived situations. Thus, when children learn to read, their experiences when reading or listening to reading become important both as part of the physicality of the reading experience and as part of attributing meaning to the text.

By arranging reading-aloud sessions as multisensory and social events that invite children to voluntarily participate, the early childhood teacher may lay the ground for positive experiences and a continued interest in engaging with reading activities. Additionally, such shared reading experiences have significant importance for the development of reading comprehension and vocabulary as books present a wider vocabulary than experienced in ordinary conversations (Chapter 3, Schilhab et al.). Of particular importance, reading aloud helps children train those imagination processes so important to reading comprehension and convergent and divergent thinking processes.

As the materiality and new affordances of reading and writing are profoundly changed by digitalisation, it is important to acknowledge the effects this has on the embodied experience of engaging with literature and expressing oneself through written media. As the change in material affordances also changes the interaction with text, it is important to be aware and make informed choices when choosing reading and writing media—it should not always be assumed that digital tools are qualitatively better or more efficient (Chapter 6, Korte & Körkkö).

Optimally preparing coming generations for various technologies and their affordances requires an improved understanding of how to enable and constrain reading and writing practices towards different outcomes (Chapter 5, Trasmundi & Bro Mangen). At the same time, it is equally important to continue

teaching learners to write by hand so they can develop various motoric and visuospatial skills. While writing by hand is seen to elicit a more embodied approach to producing text that supports a more material engagement and leads to better memory of the content, this needs to be balanced with the necessary digital skills that align with contemporary demands in society (Chapter 6, Korte & Körkkö). A variation of writing methods will strengthen the different stimulative embodied cognitive processes that learners must adopt to effectively use different writing substrates and their affordances. Learners must be supported from early on to develop balanced handwriting and typing skills so that they can play an active role in our digital world (Chapter 6, Korte & Körkkö).

When it comes to creative practices, such as arts and crafts, this book lifts the importance of learning by doing and making (Chapter 9, Groth & Gulliksen; Chapter 11, Groth) and material engagement (Malafouris, 2018). Also, this field is undergoing a shift in materiality that affects the way students and practitioners engage with materials and tools (Chapter 10, Søyland). Affordances of analogue and concrete materials are fundamentally different to the immaterial and digital tools and hybrid making that are introduced into the arts and crafts classrooms. While there is no doubt that digital technologies provide other potentials for making—some which surpass traditional means by far—there is a concern that this also brings challenges related to embodiment.

Central to arts and crafts education is that it offers unique possibilities to establish a dialogue with materials and connect with the physical world through engaging with it (Chapter 9, Groth & Gulliksen; Chapter 10, Søyland). In such a process, materials challenge us and provide different types of resistance or opportunities as we explore and interact with them. Additionally, craft practices offer arenas for safe failing and recovery—a process that builds resilience and endurance and the capacity to wait for rewards (Chapter 9, Groth & Gulliksen). A shift from physical real-world experiences like whole-body drawing to extensive use of digital technologies entails a shift in the learners' spatio-temporal relation with materiality. Analogue and especially whole-body drawing, for example, involves risk-taking and a real-world experience that digital drawing cannot offer. Teachers are encouraged to let pupils express themselves in varied ways and work in diverse types of formats and environments. Engaging pupils in, for example, large-scale drawing outside on a windy day or lying on the paper while drawing with charcoal, even in the dark, highlights the experience of thinking through drawing and connecting with the environment (Chapter 10, Søyland).

By externalising ideas into visual and 3D representations, students can extend their learning and thinking processes into the environment and make them concrete. In creative practices, the materiality of a situation can act as an epistemic medium, meaning that learning happens in the act of experimenting and reflecting through material means (Chapter 9, Groth & Gulliksen). The artefact progresses the enquiry but also visualises the process and the results of it. In this sense-making process, the hands often form the point of interaction

between person and material, as if thinking through the hands and the material (Chapter 9, Groth & Gulliksen). Additionally, by concretising conceptual ideas in matter and using materials as scaffolding tools in complicated systems, the learner can off-load cognitive tasks to the environment, as well as collaborate with others on the same tasks. Arts and crafts thus work as a premise supplier for other school subjects in which learners may test and engage with content knowledge in multimodal embodied ways. Artefacts that are formed as a result of longitudinal and personal processes of engagement may become very important for the learner or maker, as they carry and embody the process of engagement (Chapter 9, Groth & Gulliksen; Chapter 10, Søyland).

In craft learning traditions, such formative learning experiences extend into the socio-material learning context, involving learners in a community of practice (Lave & Wenger, 1991). In these conditions, the learner is culturised to embody not only manual skills but also habitual and gestural patterns and movements that are shared by practitioners in the same community, making a deep imprint on the learner's understanding of self and identity. Such culturation of the learner is not relevant in today's educational system, where learners are not aiming to be professionals in one area but rather interdisciplinary renaissance knowers of a large repertoire of subjects. However, apprentice learning may be utilised in more embodied explorations of a subject matter— for example, by contextualising a situation (Chapter 11, Groth). While visiting real studios and experiencing practices and materials in their right contexts would be preferable, using external resources to bring the experts to the students in an audio-visual form may help convey the context and situatedness of the practice. Carefully selected or created videos bring the world into the classroom and give a multimodal dimension to the practice under study (Chapter 11, Groth).

In sports, the role of the body and the more tacit forms of knowing in action are inevitable; here, thinking through action is at its most evident form. However, thinking consciously about how to make a certain action can distract from performing the task at hand, as the whole-body performance is building on muscle memory drilled through countless repetitions that have become automatic and implicit. Such drilling of the body to perform seamlessly and perfectly to achieve goals set by someone other than the performer has been the norm in many sports and physical education. However, such "pain for gain" thinking objectifies students for the purpose of curricular and political goals and might distance students from their sensitivity to their own bodies and the resonance between themselves and their environments (Chapter 16, Engelsrud). By attending to the psychophysical nature and sensitivity of a student, we can align better with the whole person and their needs and abilities in a more positive and compassionate manner, one that might advance the student's relation with their body and its capacities (Chapter 16, Engelsrud).

When engaging in activities that are performed while interacting with others, more than only one's own intentions must be considered. Dancing in pairs or acting and reacting in a dual constellation, such as in martial arts, one's own

actions must be dynamically performed at a high level of speed and preci-sion—also involving bodily interpretations and improvised counter actions based on what the partner is doing. In such a "dance" of mutual interaction, there is no time to consciously think; instead, what happens is a simultaneous bodily reflection in and through action—the ultimate example of embodied cognition (Chapter 17, Ravn). Not only are we moved and affected by the partner in our interaction, but the event also has a life of its own, and the dynamic of the event as a whole "potentially shapes *and* transforms" pupils' movements and their embodied experience of these movements: the situation moves beyond control and potentially to the point of not knowing. In such situations, students may find themselves being danced by the dance, moved by their martial arts partner, or played by the game—a truly embodied interaction with the situation and the environment (Chapter 17, Ravn).

In music classes, static and preconceived styles of teaching that overrule the student's intentions and sensitive connection with the music and environment may be detected. In such teaching traditions, the primary concern is to teach musical notation, and formal music training is focused on learning to play pre-composed scores on standardised instruments. Such an approach has led to thinking about music as a "thing" rather than an active and interactional pro-cess. By thinking of music-making as an activity, or as "musicking", teachers may invite pupils to engage with sounds and instruments in an enactive man-ner. When musicking, students not only interact with the instrument but also with the sounds it makes—a merging of the student's actions and interactions with the instrument that results in an audible environmental artefact. Listening to music is an embodied activity, exploiting the multimodal capacities of our whole bodies in taking music in and letting it move us both bodily and emo-tionally (Chapter 15, Jensenius).

New music performance technologies challenge traditional teaching set-tings in music. For example, laptop musicians often perform with software that works in both real-time and non-real-time modes, and for them, composing may also include building the instrument, further blurring the boundary between instrument maker and composer (Chapter 15, Jensenius). Some art-ists even release apps with multitrack versions of their songs that users can modify at will. This opens for more "active listening", in which the perceiver becomes a performer and participant as they actively engage with the musical material. Such new music technologies are not yet "classroom ready"; how-ever, they carry much potential for thinking about music learning as an active engagement. Creating new music, even new instruments or ways of exploring sounds instead of learning ready-made chords, moves music education towards an embodied practice of musicking (Chapter 15, Jensenius).

Children's relationships to their natural environment have changed over time, from frequent and largely independent roaming in forests, green envi-ronments, and urban undeveloped lots to mainly indoor activities and con-trolled visits in nature designed by adults. Similarly, children more often learn about the natural environment in a classroom, while there are significantly

more experiential and embodied learning opportunities available when lessons are designed as situated and contextualised—for example, in a forest (Kiefer & Trumpp, 2012). There is an emerging field of nature-based learning approaches that encourage situated educational practices. While technologies can be partly blamed for the shift away from nature, technology may be used as a tool to enhance rather than diminish children's connections with nature (Chapter 13, Esbensen et al.).

Smartphones are a promising technology in the field of outdoor education: the use of nature apps, internet access, and the ability to have a camera, notebook, and audio recorder at hand can enable new child-led connections with nature, stimulating curiosity about the natural environment. Through engaging educational apps with built-in game-like motivation, pupils can earn badges as they identify and document different natural species. Teachers may thus place greater focus on the benefits of situated and embodied learning through the use of smartphones to teach pupils to be active and curious knowledge seekers through technology and science subjects that take place in nature (Chapter 13, Esbensen et al.).

Research on outdoor schooling suggests that natural environments stimulate perceptual processes critical to basic science learning. Scientific reasoning relies on sensorial and attentive empirical observations, hypothesis testing, and theoretical assumptions explored in experiments. In outdoor science explorations, perceptual and bodily interactions are embedded in the natural environments that are being studied. Equally, experiencing artworks may engage pupils in sensory experiences and reflection, offering alternative ways for engaging with natural and science-based phenomena (Chapter 14, Schilhab). By combining scientific exploration with aesthetic experiences, content knowledge may be opened in new ways. In a scientifically oriented art exhibition, a pupil may take their time to attend to and perceptually dwell on tangible phenomena and installations. Opportunities to engage in creative practices also offer means to process and embody the studied topic in new ways that give meaning on a perceptual level (Chapter 14, Schilhab).

Digital tools are here to stay, and the digitalisation of all aspects of society also means the integration of digital technologies in education. Not only is this affecting teachers' pedagogical approaches, but they also shape them. At the same time, as teachers struggle to keep up with technological advances and new tools, there is a need to prepare learners for tomorrow's technology-rich society (Chapter 12, Korte & Körkkö). In this context, it is important to take control of the tools and make them purposeful and relevant rather than using them blindly or for the sake of the imagined progression they are connected with. There is a need for embodied digital pedagogical practices that respect learners' emotions and have a holistic perspective on learning—and that are experienced as meaningful by both teachers and pupils (Chapter 12, Korte & Körkkö). Technology-enhanced, embodied learning environments and educational technology involving embodied learning designs derived from the 4E embodied cognition framework are being developed but still need

pedagogical infrastructures to be meaningful. This book introduces such a technology-enhanced embodied pedagogy while providing a reference for practitioners who seek to design technology-mediated learning experiences that link movement and learning objectives (Chapter 12, Korte & Körkkö). The teacher can still take advantage of the embodied learning approach with non-digital media or even without any media at all, as the world is inherently physical and full of potential for embodied interaction.

Theoretical subjects such as mathematics or sciences might at first seem like subjects that are less "embodied", using more intellect than body-based practical subjects, such as sports or arts and crafts. However, such division into the theoretical and practical subjects only reiterates already rejected dichotomies, such as body and mind. In fact, subjects that are thought of as more theoretical, abstract, or conceptual are also grounded in human-environment coupling and sense-making. By taking an embodied perspective in education, we may build on this understanding and utilise the afforded benefits. After all, these are not new phenomena—for example, mathematical computations have long been aided by externalising the task to beads, fingers, or numbers drawn on paper. Through this anthology, we would like to once and for all move on from thinking of some subjects as more important or relevant due to their relation to what is called intellectual subjects. Our message is that all learning is embodied in nature, whatever the subject matter.

Inspiration for your own practice

We have only covered parts of what an embodied cognition approach offers teaching. And maybe you have already anticipated or even trialled your interpretations of embodied teaching techniques in your own practice. If you are teaching physical education or an aesthetic discipline like music or visual arts, the leap to an embodied perspective is probably not far. On the other hand, if you are uncertain about where to begin because you are teaching disciplines that mainly take place in the classroom, paying attention to how to operationalise 4E(+) in your particular circumstance may be both revelatory and encouraging. We suggest that you begin by following the checklist below and take the time you need to carefully consider our guiding questions. This list is not meant to be complete; however, it provides a starting point from which you can develop your practice of embodied teaching.

Embodied cognition entails acknowledging that learning should literally *make sense* to the learner. This may come from engaging the learner in whole-body *enactive* activities involving sensory-motor activities which are known to promote well-being and motivation for learning. Whole-body activities inherently call upon learners to be alert and present in the moment by prioritising the perceptual element of the learning situation. An activity can stimulate all senses when pupils are allowed to move about in a natural environment rich in sounds, colours, and odours; shifts in ambient temperature, moisture, and light intensity; and typically also with uneven terrains. Natural environments

are also ripe with other organisms whose activities and daily life cycles often tacitly endorse the perceptual processing in the learner. Just think of how chirps from nearby birds, the swirling of insects, and the gentle stirring of leaves and grass by a passing breeze embrace us in a vibe of life even when we are not really paying attention to it.

Ask yourself whether the teaching you are about to do could actually take place outdoors, where your pupils could move about to investigate the environment, sharpen their perceptual acuity, or solve questions. How would you ascertain that the pupils engage in whole-body activities and that their stay in the multifaceted environment benefitted their perceptual and enactive minds?

A learning situation can similarly draw on aspects of the sensory-motor activity when pupils are requested to draw, dance or process their impression using, e.g., clay modelling, musicking, or cutting out cardboard shapes. Prioritising particular senses is just one significant asset when using aesthetic work as a didactic tool. Another is the unique turning of an impression into an expression for the learner. Here, sense-making is translated into material being, which helps the learner to mentally engage with, explicitly reflect upon, and thus increase the chances of retaining and later remembering what was learned.

Stimulating embodied cognition through aesthetic activities also fosters important introspection, preparing the pupil to get in touch with their own sensations, sentiments, and experiences of values, as well as their sense of responsibility for the creation and ownership of their learning. When transforming their feelings and values into something shared, these feelings become visible and tangible. In other words, the innermost comes into a recognisable existence that can be related to in novel ways.

Ask yourself if the learning situation you create would benefit from more silent contemplation accompanied by creative, reflective moments where pupils could draw on their own associations and inner values and feelings, which could later be shared with, e.g., classmates and family. Would the creative process and the actual end results aid in achieving the goals you have set forth for the lesson?

The setting where learning is occurring can be changed by incorporating spaces outside of school, such as the local area or a nearby street. Manipulating the learning space can also happen by visiting places like local businesses and science and cultural centres.

However, manipulating *embeddedness* does not have to be overly demanding. Try, for example, to do some teaching in a large shared space within the school, where pupils can organise their learning bodies in new ways and vary their postures or use music, light, or odours to accompany the teaching.

When teaching language, history, or physics, you could highlight themes and associations by wearing relevant clothes and maybe even ask your pupils to imagine what to wear or bring items of relevance to the subject. You could also involve them in role-playing, where they practice imagining the lives of historical or narrated persons. Consider how learning about gravity would take on an

emotional dimension if pupils were to reenact Newton's experience of a fallen apple together with laboratory work.

When you manipulate the learning environment by involving certain objects and artefacts, you are also *extending* the learning mind. You can use materials in the surroundings to reinforce particular mental states when they act as referents, e.g., in language learning. However, you can also use objects to fortify learning situations by providing concrete context for the learning. Objects are formidable as vehicles for associations and indispensable as a common third by which we can synchronise our shared understanding when using, e.g., graphics, globes, and various instruments.

Ask yourself whether the topic you are teaching may seem fairly intangible and would benefit from material anchors (Hutchins, 2005) that could simultaneously concretise and align your pupils' attention. Also, ask yourself whether you have offered sufficient connections between what the pupils embody and what they are supposed to explicitly understand or whether the learning would benefit from the many associations and inspirations that may occur when your pupils are exposed to concrete instantiations of theoretical content.

Obviously, changing a more traditional and sedentary learning environment to support an embodied activity is not trivial. The switch depends on much more than imagining new ways of teaching. Time, economy, and specific school cultures may hinder changes to your teaching techniques. Also, school administrators, parents, colleagues, and even your pupils may challenge the feasibility of implementing teaching inspired by the embodied cognition approach. It is highly conceivable that pupils of a certain age need to learn what you aim for by these radical changes in order to understand what is expected of them and how they should behave when learning regimes are no longer restricted to sitting passively at a desk in the classroom. As with all educational approaches, the dynamics and logic of the working processes need to be adopted by the pupils to work effectively.

However, even minor changes—like wearing clothes inspired by historical sites and ages, having pupils draw and express what they experience, or engaging pupils in role-playing activities to simulate and reflect on life worlds that are different from their own—can make a wonderful impact. Hopefully, the occasional successful implementation of embodied approaches prepares the education system for more pervasive changes in due course.

References

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42.

Hutchins, E. (2005). Material anchors for conceptual blends. *Journal of Pragmatics*, *37*(10), 1555–77. https://doi.org/10.1016/j.pragma.2004.06.008

Kiefer, M., & Trumpp, M. N. (2012). Embodiment theory and education: The foundations of cognition in perception and action. *Trends in Neuroscience and Education*, *1*, 15–20.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by.* University of Chicago Press.

Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation.* Cambridge University Press.

Malafouris, L. (2018). Bringing things to mind: 4Es and material engagement. In A. Newen, L. de Bruin, & S. Gallagher (Eds.), *The Oxford handbook of 4E cognition* (pp. 755–71). Oxford University Press.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review,* *9*(4), 625–36. https://doi.org/10.3758/bf03196322