CULTIVATING THE INEFFABLE: THE ROLE OF CONTEMPLATIVE PRACTICE IN ENACTIVIST LEARNING

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> Mathematics, like music, needs to be expressed in physical actions and human interactions before its symbols can evoke the silent patterns of mathematical ideas. (Skemp, 1983, p. 58)

Scholars of education since Rousseau share similar visions of mathematics pedagogy: children engaged in learning new content should first experience interesting situations and only then express their experiences in the various forms of the discipline. And yet, through the ages of educational scholarship, students' semiotic passage from informal situations to formal models has proven challenging to theorize and practice. In response, research has focused on understanding the conceptual knowledge and procedural competence students must bring to bear in order to successfully symbolize their experience.

In this article, we step back and focus not so much on the formalization of experience as *on experience itself*—the pre-conceptual and conscious sensations that are to be symbolized. Examining the nature of the sensations students experience as they engage in pedagogical activities appears to be a useful endeavor for any research program oriented to understanding how these sensations may give rise to conceptual knowledge. Yet this area of research is relatively under-represented in the literature.

How should researchers conceptualize students' pre-symbolic experience? Drawing on enactivist perspectives, we view the cognitive activity of pre-symbolic reasoning as constituted of embodied, situated action, whence meanings arise (Varela, Thompson & Rosch, 1991). As such, we investigate the source of mathematical meanings by looking to students' phenomenology of pre-conceptual experience and asking how these experiences rise to consciousness such that they can then be symbolized. We submit that students' first challenge in modeling their experience, antecedent to mathematical symbolization, is that of *accessing* their pre-conceptual experience, a bottleneck, we maintain that has largely been overlooked.

Our focus, in this article, on the originary phenomenological sources of mathematical reasoning, moves beyond cognitivist approaches to examining mathematical incomprehension, such as focusing on issues of working memory, semiotic representations, and varied aspects of cognitive function and dysfunction (*e.g.,* Geary, Hoard & Hamson, 1999). We propose to shift the investigative locus of research on mathematical learning to earlier phenomenological events in students' subjective process of meaning making, just prior to engaging in formal mathematical representation and modeling of psychological content. Our proposition rests on the adoption of a contemplative orientation that promotes a deep focus on somatic and pre-conceptual realms. In our development of this approach, we introduce contemplative practice as a means to resolve the bottleneck introduced above. Contemplative practices can do this, we suggest, by providing a pre-conceptual or liminal space that bridges the nuanced apprehension of tacit sensorimotor activity and conscious configuring of this ineffable psychological content into expressive forms.

On the contribution of contemplative practices to problem solving

In our examination of contemplative practice for mathematics problem solving, we signpost the need to foster the non-judgmental states and reflective spaces that can arise in these practices, while understanding that these states can act as liminal pre-conceptual zones of *unknowing*. It is in these zones that the bodymind can work on the "tangle" of subliminal perception, proprioceptive awareness, and unconscious registration (Claxton, 2006) immanent in the experience of solving mathematical problems. The use of contemplative practices for problem solving is well known in the field of contemplative education (*e.g.,* Hart, 2008) and is being developed to fit specific disciplines such as contemplative law (Riskin, 2002) and nursing (Raingruber & Robinson, 2007). Raingruber and Robinson (2007) researched the use of somatic contemplative practices such as tai chi and yoga with nurses. In their study, they found that "along with noticing an increased problem solving ability each of the nurses also commented on physical sensations or visual images such as warmth, pulsing sensations, or colored lights" (p. 1147). Significantly, they discovered a direct correlation between contemplative somatic focus and problem solving, for the nurses' ability to notice relevant clinical cues was directly correlated with the development of their proprioceptive awareness.

Reflection on these findings and the concept of contemplation as a liminal space of learning initiated this article. It consists of two offerings: (1) a discussion of theoretical positions pertaining to deep focus, the phenomenology of pre-conceptual situated sensorimotor experience and learning; and (2) a report on findings from two pilot studies that

sought to create empirical settings where our proposal may play out and thus be evaluated. This essay is hence primarily a thought experiment seeking to elevate the community's attention to a potentially important area of scholarship and research.

This essay is introduced by the first of two short exploratory exercises that illustrates our proposition that contemplative practice can offer solutions to the bottleneck problem by orienting students not to their explicit thoughts, but to nuanced somatic-kinesthetic sensations within the liminal contemplative-embodied/cognitive stratum. In asking how contemplation does this, we introduce the influential work of John Mason and Wolff-Michael Roth. Beginning with Mason's *discipline of noticing,* we highlight similarities between noticing and deep focus in contemplation. While Mason's emphasis on the heightened sensitivity and attention needed for problem solving is relevant, his concentration on problem solving stages that occur at the edge of pre-conceptual space led to our engagement with the process philosophies of Eugene Gendlin and Alfred North Whitehead. Their philosophical work, and that of Roth, offers insight into the foundational ground and processes of a liminal space of problem solving, as does our outline of two short exploratory contemplative mathematics experiments.

Investigating the contribution of contemplative practice to mathematical learning

Our thesis on the contribution of contemplative practice to the emergence of mathematical meanings was recently explored by one of us (Morgan) in two short experiments, as she now describes.

> In the first experiment, I sought to develop points of productive intersection between contemplative practice and the embodied interaction (EI) exercises for mathematics developed by Abrahamson and Trninic (2011). Working with Angela, a past student from my Meditation Lab program, I began by introducing Angela to a range of contemplative slow-stretching or yoga-like exercises developed to induce relaxation and deep focus in the body. These somatic contemplative exercises provided entry to a contemplative liminal space that then arose through Angela's practice of four mathematically focused contemplative somatic exercises. I modeled two exercises related to geometric figures and two centered on aspects of proportion, with Angela mirroring the movements. Shorter versions of the first practices occurred at two points in Angela's deep engagement with the contemplative mathematical practice to help her maintain focus.
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> One of the exercises was a "low tech" simulation of Abrahamson's technologically facilitated design for the mathematical content of proportionality. Abrahamson's activity rationale is to create opportunities for students to engage in problem solving manipulation tasks whose solutions foster the development of new sensorimotor coordination schemes centered on new phenomenological objects that ground challenging mathematical concepts. The focus of this design, on solving a dynamic physical movement problem and then articulating and modeling the movement itself, gives rise to unique effects of mathematically focused contemplative somatic practice.
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> In the exercise, Angela and I sat facing each other while I placed my hands level in front of me and then, while raising both hands, gradually moved them apart to create an expanding gap, and then while lowering both hands, I contracted the gap. As this gap grew and decreased, Angela emulated the movements. Following this part of the exercise, though still in the liminal space, Angela was asked to draw on a page that had a grid on it and to interact with a sheet that had a soft grid made of black ribbons attached to the sheet. In brief, the preliminary somatic contemplative yoga-like movements supported Angela's movement into a light contemplative state. Once in this state the more mathematically focused exercises provided the liminal space for Angela to engage pre-conceptually with a range of possibilities from which a feeling could arise. As she exited the liminal space, the drawing and soft grid were provided as a bridge between the pre-conceptual and conceptual, on which she could solidify feelings into symbols before using words. Lastly, Angela discussed her experience with me. Through this discussion and after observing her drawing and manipulation of the soft grid, we were interested to find that Angela's pre-conceptual feelings had hardened into mathematically oriented symbols. For example, in the contemplative creative practices, Angela created funnel-like shapes that grew proportionally; in the debriefing at the end of the exercise Angela emphasized her feeling of the size of the gap between her hands changing (proportionally) saying:
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> > I had this real feeling of the gap between the hands, keeping the space between them, and I guess they were kind of like the fingers [*indicates the moveable lines, created by ribbon*] and just having this space in-between and just feeling this space and this feeling of rising and falling [*indicates the lines on the graph that she has drawn*] and again like rising and falling. Yeah I was really conscious of the space and also the mirroring [*moves her hands to replicate the space*] kind of feeling and the going up and down. I guess it was hard to maintain the same amount of space between our hands when we were doing the exercise—you really had to pay attention, focus. This space seemed to have a certain energy that fluctuated and changed in size and it was my focus when doing the exercise.

Our submission of these practices and the liminal space they bookend, illustrated byAngela's experience, is in part founded on Gendlin's (1962/1997) proposition that experience is "non-numerical". He argues that there are no units of experience pre-organized into schematic relationships, but rather there are endless potentialities of relations and differentiations. To know these potentials as the pre-conceptual

ground of experience prior to any symbolization requires the heightened awareness provided by contemplation. In his investigation of problem solving, Gendlin (1962/1997) asks "when finally the 'suggestion' occurs and a possible solution is symbolized, what has occurred in between?" (p. 73). In response, he answers that there are always "felt meanings" that may solidify in problem resolution or simply remain "mulled" or "sensed". Contemplative practice, we contend, helps sustain awareness (particularly a non-judgmental, open and flexible awareness) in pre-conceptual experience long enough for the *feeling* of the answer to arise and harden. Expanding this process, Gendlin describes the initial engagement or reflection on a problem, starting with the individual's knowing or grasping of some aspect of the problem: a "thatness" (what they already know) of the problem. The individual reflecting on a problem uses the thatness as a "grip" or reference with which to identify the felt meanings of each aspect of the problem. As Abrahamson and Sánchez-García (2016) argue, the sense of "grip" is literal; it is phenomenologically valid, because students engaged in these bimanual manipulation tasks spontaneously evoke new perceptual structures from the field of potential enactment. These "attentional anchors" are constellations of loci demarcating motion patterns that solve the coordination task: apprehending attentional anchors collapses bimanual sensorimotor control onto a single element, the new mathematical object to be. Finally, these feelings resolve into symbolization, the mathematical object or problem resolution.

Foundations of enactivist contemplative mathematics

The ground has been laid for an enactivist contemplative mathematics by a number of theorists, though we focus here on the contributions of Mason and of Roth. We start with Mason's *discipline of noticing,* which entails refining the natural ability of "ordinary noticing", a process that can be found in contemplative inquiry. As with contemplative theorists (*e.g.,* Roeser & Peck, 2009), Mason identifies a "natural" or inherent ability, honed through practice, which can then be applied in personal and professional life. While Mason (2002) does not refer specifically to contemplative practice or theorists, he emphasizes the need to work against "the tendency to forget, to not notice, to be so caught up in your own world that you fail to be sufficiently sensitive to possibilities" (p. xi). Mason (2003) stresses the importance of sensitivity for learning through "attention", the prerequisite for noticing. He then asks what changes when something is learned, and answers that the structure of attention changes, or as he terms it the "sensitivity to notice" (p. 17).

In Mason's (1989) interrogation of mathematical thinking as abstract thinking he examines heightened focus or noticing and the need to apply it so as to experience the delicate shift that occurs as form is abstracted from the sensible. Mason emphasizes the need for deep attention (noticing) as it is a very rapid and delicate shift of attention, which draws form out of the elemental ground of the sensible. He reinforces that this abstraction rests on a prior experience of knowing the form in the "sensible"; the "abstraction" then follows as it resolves from its primal origins. This is also where our work departs from Mason's, as his *discipline of noticing* skims over the fertile ground of the "sensible" to pursue "aspects of abstracting", particularly "the momentary movement from articulating to manipulating" (Mason, 2003, p. 3). In the ontology of somatic pre-predicative learning we are developing, this "movement" is a stage that follows a more foundational immersion in the sensible or pre-conceptual. We understand this primary stage to ground all others and visualize it as being accessed in a liminal space provided by contemplative practice, where the solution to a mathematical problem filters through somatic pre-conceptual experience to emerge as form, as problem resolution.

We imagine how this process happens following Gendlin's (1962/1997) tracking of the emergence of meaning from experience. Firstly, Gendlin differentiates experience and "direct reference" or description of experience in language. Experience is grounded by the "pre-conceptual", a foundational characteristic of experiencing. Importantly, the living body is not only an accumulation of material parts; it also consists of unfinished or potential patterns that can arise out of the body's interaction in the world. In this way, "the body is one interpenetrating system in which every aspect of order involves every other aspect" (p. 25). This ecological body also contains an inward bodily sensitivity with the same interweaving form. Because of the unlimited number of possible patterns that the inner and outer body can engage, there is no logical schema that can represent them. As Gendlin says, the actual order is "supralogical", though a particular logic can be assigned to aspects of the supralogical. These aspects are symbolized (given conceptual form) in multiple ways, depending on point of view, context, and schemas applied. Underlying what is symbolized are *feelings* which remain incomplete, they are immanent potential: "an *orderly* relationship to symbols—*when* symbols occur" (p. 28). These feelings arise out of the patterns and, when felt, undergird the symbol that forms from them.

We postulate that these pre-conceptual feelings are more readily accessible in the liminal space provided by contemplation. Further, as can be seen in the experiment with Angela, the potential for mathematical symbols to solidify out of these feelings can be cultivated by contemplative, somatic, mathematically-oriented practices conducted at the entry to the liminal space and birthed at the exit with contemplative creative practices. In effect, the contemplative (mathematically focused) somatic practices refine or direct the practitioner's body/mind/consciousness toward mathematical *feelings* and then symbols, while the somatic creative practices act as a bridge between the pre-conceptual and the symbol creation or cognitive problem resolution.

First-person experience and problem solving

Roth's (2012) examination of problem solving is phenomenological and grounded in a first-person examination of what he terms "critical problem solving events" in his life. Paraphrasing Husserl, Roth alludes to his application of the *epoché* or bracketing of pre-conceptions as he describes how in his recording of these events, they "gave themselves to him". Further, he emphasizes the importance, in his approach to problem solving, of attempting to capture the "first-time-through" nature of the perceptual processes in

problem solving. Like Mason's noticing, first-time-through perception is a "fully focused state of persons engaged in the present with their whole being" (p. 127). Importantly, deep concentration, which can be understood as a form of contemplative practice, is required so that presence is not "dispersed". This "dispersal" is what has led to pre-conceptual experience being deemed ineffable and, therefore, not suitable for pedagogical attention. We agree that experiences in presence or contemplation often dissolve when they encounter words but challenge the assumption that they have to evaporate at this point. Rather, we propose that the ephemerality of the feelings encountered in presence, deep focus, or contemplation can be solidified as described in the short experiment with Angela.

Roth's (2012) phenomenological examination of "presence" or the "state of pure being" builds conceptual ground for our proposition of a liminal space entered through contemplation, in which mathematical problems can be engaged pre-conceptually. While Roth provides extensive and vivid description of a number of repetitive physical activities, such as weeding and cycling, which can be understood as providing somatic contemplative space, he finds the essence or ground of these experiences impenetrable. However, he does allude to primal forces at work in an original space where presence resides, suggesting that the "state of pure being is not completely empty because, when consciousness explicitly returns, there is a resonance of what has been an echo" (p. 127). Using the memory of a dream as an illustration of the echo, Roth presents it as proof of an engagement in the ground of pure being. The problem at this point is that "immersion overflows and carries off any kind of analysis" (p. 127).

We depart from Roth's analysis of essence and presence at this point, suggesting rather that contemplative creative and somatic practices provide the means to identify, solidify, and describe what can dissolve when one moves from the pre-conceptual to the cognitive, be it the dream and its recollection or contemplative pre-predicative engagement with a mathematical problem and problem resolution. We acknowledge that it is difficult to grasp the compresence of the consciousness and unconscious described by Roth as the "conscious diving of consciousness into unconsciousness that it allows to rise within itself while sinking into it" (p. 127). However, his articulation of this diving as a process involving agency and passivity may not be the best way to characterize it. Rather, we suggest a process approach and, later in this article, look to Whitehead's *Process of Feeling* outlined by Rothfield (2009).

Heightened attention and contemplation

Heightened awareness or sensitivity to the object of focus is central in contemplative practice and education (Morgan, 2012). It is something the music pedagogue Shippee (2010) highlights with his claim that "teaching creative expression means teaching sensitivity, and teaching sensitivity means teaching mindfulness" (p. 80). The physiology grounding this sensitivity, contemplation, noticing or, in this case, deep focus in a mathematical problem, is detailed across the past forty years of neuroscience, and contemplative practice research. Despite findings in neuroscience and meditation research being contentious, it is safe to say there is a form of brain plasticity associated with contemplation that is linked with enhanced executive function [1] (Koziol, Budding & Chidekel, 2012). In particular, the heightened metacognition and focus, lowered stress, anxiety and depression and increased ability to retain and retrieve information are signaled by theorists in the emerging field of contemplative mathematics, including Brady's (2007) development of mathematics pedagogy, Brunyé *et al'*s. (2013) use of contemplative practice for students suffering high math anxiety, Rodd's (2006) examination of mathematics, emotion, special needs and the use of "meditational mathematics", and Wolcott's (2013) investigation of intentional structured reflection for mathematics researchers. The remedial benefits of contemplative practice described by these theorists are echoed throughout contemplative inquiry and understood here as the first step in a comprehensive contemplative mathematics.

The neurophysiology of these benefits is charted in the seminal work of Lutz *et al.* (*e.g.,* 2008) and Lazar *et al.* (*e.g.,* 2005), who delineate the neural correlates of sustained attention. In brief, their work and that of an increasing number of contemplative scientists has shown that regular meditation practice is associated with altered resting electroencephalogram patterns suggestive of long-term changes in brain activity. These changes are situated in the frontal cortex and relate to brain regions associated with heightened executive functions. Reflecting on their own and a range of studies, Lutz *et al.* (2008) suggest that "several subcomponents of attention are best regarded as the product of trainable skills, and that [focused attention] meditation represents a family of mental practices that are explicitly designed to train such attentional focus" (p. 165). Researching in a similar area, Lazar *et al.* (2005) used Magnetic Resonance Imagining (MRI) to examine the impacts of meditation on the right brain hemisphere, an area of the brain essential for sustaining attention. Their findings suggest that the right anterior insula of long-term meditators is thicker than non-meditators, which is important, as this area of the brain relates to bodily attention, increased visceral awareness and executive function (Lazar *et al.,* 2005).

Also relevant is the work of Kerr *et al.* (2013), who found that a somatic form of contemplative practice can result in "top-down modulation of the thalamocortical alpha rhythm, which facilitates faster and more sensitive filtering of sensory information to the brain" (p. 12). They claim that practitioners' ability to control alpha oscillations through somatic focus may be a "gateway mechanism" that enables thalamocortical alpha regulation of irrelevant sensory inputs across the neocortex using regulation methods such as selective attention and working memory. The way contemplative practice can "heighten" this selection or regulation of sensory input, in part, suggests how it may clear space for somatic pre-conceptual immersion in mathematical problems.

The contemplative liminal space and problem solving

We believe, as Mason and Roth do, that a heightened ability to focus supports the sensitivity and refinement of consciousness that enables access to an original ground of learning and problem solving. For Mason, this ground is

the "sensible", and for Roth, "essence". We do not name the original ground as Mason and Roth do, but we suggest that contemplative practice provides the means to enter liminal space where it can be accessed. Allen and Bickhard (2015) speak of "lower levels" that "serve as the origins of [...] tacit knowledge, sub-personal representations, procedural know-how, unconscious heuristics, system one processing" (p. 248). We add pre-conceptual contemplative knowing to this list and look to Whitehead's process philosophy to develop some understanding of the essential ground in which it arises. In Dewey's development, such a ground is useful; he proposes a "noncognitive or precognitive, qualitative 'background'" (Garrison, 1996, p. 393), from which the "foreground" of cognitive thought emerges. Residing in this background are, according to Garrison (1996), need, affect, intuition, selective attention, and imagination, which in the liminality of "emerging inquiry", are translated into "linguistic propositions". While we do not confirm these contents of the "background", "sensible", or "essence", we do acknowledge that a process of learning occurs in pre-conceptual space, which can result in linguistic propositions or cognitive meaning making. Despite the focus in mainstream education on the final or cognitive phase of learning, it is important to remember that this cognitive phase is continually qualified by its noncognitive background or Dewey's "context of thought" (Garrison, 1996). Importantly, Dewey emphasizes that the pre-conceptual background and cognitive foreground are not separate, but rather they influence each other in ongoing processes of change or learning.

Following Dewey's lead, we look to the emergence of creative process to further understand the pre-conceptual background. Engaging Rothfield's (2009) exploration of her dance practice, we are reminded of Mason's (1989) experience of a *sense-of*, which "accompanies or is associated with the expression, and which does not disappear when the expression becomes an object of attention" (p. 3). Rothfield's (2009) *sense-of* occurred as she danced; it appeared in the *feeling* of the dancing and anchored her realization of choreographic material that had previously been inaccessible. Describing this feeling she says:

> By a series of happenstance, something emerged inside my dancing body. I was not authoring anything. But deep inside, there was a thickness of feeling which I felt. It permeated my torso. If I pushed out of the ground from a bend/plié, I could feel that deep inside get pushed from the ground. (p. 2)

The intense somatic focus in her dance practice, a part of which entails feeling into the minutiae of movement, made it contemplative and so allowed this thickness of feeling to emerge from the liminal space of her practice. From this initial experience, Rothfield experimented with a range of "thick-from-the-inside" activities, solidifying the initial ephemeral experience. She then engaged Whitehead's process philosophy and, in particular, his understanding that there is an uninterrupted oscillation between the old and new. This rhythm is described by Whitehead as a constant motion swinging "between emergent newness and ongoing establishment" (Rothfield, 2009, p. 2). In this uninterrupted flow, or process of becoming, a "creative advance" draws part of the old with it as it establishes the new. Importantly, *feelings* are the conduit for this ongoing process and are described by Whitehead as vectors, for they are directed toward the new, entering it and forming its "subjective nucleus" (Rothfield, 2009).

Rothfield's articulation of feelings through Whitehead's *process of feelings* offers insight into problem solving in the liminal, starting with Whitehead's proposition of limitless possibilities available in the process of becoming. Whichever activity one is involved in, certain elements are chosen, in a sense unconsciously, while others are eliminated. Describing this process, Whitehead (1927/2010) writes:

> A feeling is the appropriation of some elements in the universe to be components in the real internal constitution of its subject. The elements are the initial data; they are what the feeling feels. But they are felt under an abstraction. The process of the feeling involves negative prehensions which effect elimination. Thus the initial data are felt under a "perspective" which is the objective datum of the feeling. (p. 231)

Using the example of the feeling of thickness that arose in and then changed her dance, Rothfield elucidates the *process of feelings.* Before the feeling arose, a number of eliminations or negative prehensions occurred. As she danced, there were a series of potential feelings she did not engage. Feelings could arise through possible relationships between, say, her body and the floor, between her movement and the space she was in. Then, a feeling—the thickness—arose; it was positively prehended. What is interesting is that this "positive prehension" happened or was a part of the deeply focused somatic pre-conceptual space. As Rothfield (2009) says, the feeling or positive prehension was felt but "not by 'me' so much as in the dancing itself through the activity of the dancing rather than 'my' agency. In that shift, from not-feeling my inside torso to feeling it, something new came to be" (p. 3). While Whitehead's *process of feelings* applies to all experience, it appears from Rothfield's encounter, and more broadly, for example, in flow (Csikszentmihalyi, 1997) and contemplative creativity theory (Horan, 2009; Sarath, 2006), that contemplative practice (widely understood) heightens awareness of this process. This heightened awareness facilitates problem solving.

Transferring Rothfield's experience to unravel the bottleneck in the contemplative liminal space, we provide an overview of a recent short exploratory exercise conducted by Morgan, in which a similar emergence of a feeling from the flow of experience was observed, as Morgan describes.

> It started with me taking my student, Ruth, through the Yoga Nidra practice, a somatic contemplative exercise in which the participant follows instructions to travel through their body, as the facilitator names the body parts in a particular sequence. Like Rothfield's dance practice, this contemplative somatic exercise brought Ruth deeply into her body and internal liminal space at which point she was asked to let an academic problem she was struggling with arise in the contemplative space.

Ruth is an undergraduate accounting student and this is the problem she was grappling with: CAPM = $r(f) \times [r(m) - r(f)]$; WACC = $[w(d) \times r \times (1 - T] + [w(E) \times r(E)]$. Rather than engaging the problem cognitively, I guided her to explore it through image and sensation, such as walking around it and experiencing its color and size. I gave her undirected time in the liminal space, where if viewed through the *Feelings Process* lens, she became more aware of the flow of becoming, of applying negative prehensions, and then solidification or prehension of a feeling.

In the flow of becoming, Ruth moved through two stages. Firstly, she saw her problem as a very solid red box with a cross marked on its lid. Then, as the practice continued, a large wave broke over the box and shattered it into pieces. Before speaking about the experience, Ruth was asked to draw it. In describing her immersion in the liminal space, she was able to solidify her experience in the act of contemplative drawing, which provided a bridge between the pre-conceptual experience of the flow, negative prehension and prehension, and symbolization in words which occurred at the end as she debriefed. While Ruth did not "solve" the problem, she began the process as she *felt* the wave breaking the red box into pieces. Seeing it shatter she realized for the first time that she could break the equations into pieces to help her solve the whole problem.

Conclusion

According to Varela (1999), "The concrete is not a step toward something else: it is both where we are and how we get to where we will be" (p. 7). But how do we ascend from embodied know-how to the concreteness of mathematical know-that? It is this epistemic bottleneck we wish to expand, to undo, between tacit dynamical situatedness and the explicit static forms purporting to model it. We have sought to examine the role contemplative practice might play in creating flow from pre-conceptual embodied know-how to formal know-that.

We began by expanding on the foundations for a contemplative enactivist mathematics developed by Mason and Roth through our exploration of process philosophy, noting the emphasis on deep focus or contemplation as a means to reveal the pre-conceptual *feelings* that underpin problem resolution. The parallels we found between our findings from short exploratory experiments with contemplative creative somatic practices and relevant aspects of Gendlin and Whitehead's process philosophies emphasize our proposition that contemplative practice draws attention to pre-conceptual realms and, in turn, the felt meanings contained in them. This apparent resonance led us to hypothesize that contemplative practices may positively influence students' content receptivity during embodied interaction. Further, we speculated that contemplative somatic creative states can direct student attention to nuances of internal sensorimotor activity from where mathematics ensues.

Based on our theoretical investigation and two short exploratory experiences, we cannot as yet support our hypothesis conclusively. However, we have made some first strides, both in framing this line of research and in demonstrating a means of pursuing it empirically. In particular, we maintain that the interventions experienced by Ruth and Angela afforded them the conditions, activities, and resources that were conducive for developing incorporated mathematical notions emanating reflectively from contemplative embodied interaction. As such, we have provided insight into possible ways to integrate contemplative practice with embodied-interaction design for mathematics, and offered a starting point for further empirical research.

How receptive might schools be to instructional activities based on both enactive and contemplative principles? Classroom evaluations of embodied-interaction systems make us cautiously optimistic that they bear transformative potential (Abrahamson, Gutiérrez & Baddorf, 2012). Simultaneously, the emerging field of contemplative education reports positive results (Shapiro, Brown & Astin, 2011). One might therefore assume that combining enactivist and contemplative practices will enhance the effectiveness of our learning activities.

More generally, we are motivated by the conjecture that mathematics classrooms are far more likely to use contemplative practices if curricular materials and activities were aligned with the epistemological, pre-conceptual, affective, and somatic underpinnings of these embodied creative techniques. Namely, the fashionable notion of mindfulness comes from a tradition encompassing much more than a set of heuristic mental concentration techniques. It is about listening closely, feeling intently, "entering" one's body and its internal landscapes of learning, and returning with the feelings that underpin problem resolution. As long as contemplative practice is applied only to mathematics anxiety or business-as-usual number crunching, rather than to deep embodied and pre-predicative meaning making, the field is only scratching the surface of contemplative practices and losing out on their very essence and gift.

Notes

[1] Executive Functions (EFs) encompass a range of mental operations that involve attentional and cognitive control, planning and working memory.

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