Aestheticising Readers' Experiences of 'Reading' Research: Making Visible Emotional Trajectories in Learning

Mellony Graven
Rhodes University
m.graven@ru.ac.za

Yasmine Abtahi
University of South Eastern Norway
yasmine.abtahi@usn.no

Nathalie Sinclair's MERGA 2024 keynote challenged us to communicate video data in ways that provide the reader with a more holistic and embodied experience of the data. In this methodological position paper, we take up this challenge. Through video analysis of a pre-school child and her mother engaging about counting in threes (prompted by the layout of numbers on a television remote) we address: How might we (in articles) share learners' shifting facial expressions and body language over time to reveal their emotional trajectories? When can images be considered self-evident indicators of emotions? How can we provide a more 'sensory' experience of data?

Introduction

As teacher of mathematics, we might have noticed that a learning experience is not just about verbalizing what is known—it is also reflected in learner's emotional journeys. For example, we might have noticed frustration giving way to understanding, uncertainty evolving into confidence, or doubt followed by joy when learners achieve a breakthrough. These emotional pathways in learning, often overlooked, are not secondary to the learning experience. They are often not expressed in words yet are core to learning processes. Sinclair's (2024a) MERGA keynote 'Towards embodied validity in mathematics education research' argued the importance of 'aestheticizing' the reader's experience—adopting the term from Fuller and Weizman's (2021) notion of sensory knowing. Her work in this area (Sinclair, 2024b; Günes et al., 2024) highlights the power of Dewey's (1934) theorising about experience as characterized by its "internal integration and fulfilment" (p.42). From Dewey, Sinclair (2024b, 42) highlights that "an experience features emotional intensity together with 'cumulation, tension, conservation, anticipation, and fulfilment' (p.152)". Sinclair's work and our own experiences prompted us to relook at our analysis of a video of Lila—a five-year-old sharing her discovery of counting in threes on the television remote control with her mother (Mellony). What unfolded was an explanation of her discovery followed by a series of prompts to nudge her to continue this counting in threes beyond what was visible on the remote. Previously, drawing on Vygotsky (1978) we characterized the event as a mathematical learning experience within Lila's zone of proximal development (ZPD) and analysed the way the more knowledgeable other (MKO) shifted between Lila, the remote and the mother thus generating a multidirectional ZPD (Abtahi et al., 2017). Reflecting on the way we focused our analysis on the verbal transcript and Lila's gestures on the remote we realised we avoided, in our writing, communicating the highly visible emotional trajectory across the learning experience. We noted that we included only three drawings converted from video stills of Lila's facial expressions (see Figure 1), respectively showing her: thinking, being unsure and confidently answering 15 as next in the pattern after 12. While not explicitly stated, these images were taken as self-evident indicators of these processes and emotions.

In this paper, we re-analyse the video to focus on Lila's emotional trajectory and through this engage with the methodologically driven research questions: How might we (in articles) share learners' shifting facial expressions and body language over time to reveal their emotional trajectories? When can images be considered self-evident indicators of emotions? How can we provide a more 'sensory' experience of data? We discuss the implications of our grappling and

address what is lost when we avoid explicit analysis of emotional cues visible in the expressions and body language of children that are central to guiding effective mediation of learning events.

Figure 1

Three images of expressions shared in Abtahi et al. (2017, p.284)

Reflecting on Missed Opportunities and Omissions in Earlier Work

Figure 1 drawings were converted from video images as these were not considered of high enough resolution for journal printing. At the time of writing, we accepted that we should focus our analysis on the transcript of what was said and gestured on the remote as a mediating artefact. As our ZPD framing led us to focus on Lila's cognitive rather than emotional trajectory we considered that inclusion of images would be a 'nice to have' but non-essential part of the contribution. Our engaging with Sinclair's recent work (2024a and b) and revisiting Dewey's (1934) writing leads us to argue that this assumption is problematic for a range of reasons. First, it overlooks the extent to which our witnessing and experience of viewing the video and still images taken from it, of Lila's emotions, guided our analysis of her words and gestures. Second, it excludes analysis of the key driver of the learning event (i.e., Lila and her mother's excitement and eagerness to engage around the discovery) and excludes the way emotional energies guided the mother's choice of mediation acts. Finally, it strips our ability to strengthen the validity of our claims about learning events through sharing images that can sensibly be taken as 'self-evident' indicators of emotional drivers and generate *broader* embodied experiences for the reader in interacting with data of learner expressions. While primarily a methodological position paper, we include here re-analysis of the earlier reported learning event (Abtahi et al., 2017) with a focus on how emotional trajectories drive the learning event to illuminate the above three points and answer our research questions.

Framing and Literature Review: What is a [Learning] Experience?

Like Sinclair (2024b) we link Dewey's (1934) notion of experience to *learning* experience as constituted by emotional intensity along with cumulation, tension, anticipation, and fulfilment. A mathematical learning experience is distinctive from other experiences as it involves cognitive development of mathematical ideas (such as learning to count in threes)—this process is simultaneously shaped by cognitive and emotional dynamics, including cumulation, tension, anticipation, and fulfilment. Additionally, Dewey highlights that "an experience of thinking has its own aesthetic quality" (p. 38). This aesthetic dimension, deeply rooted in emotion, "rounds out an experience into completeness and unity" (p. 41). These emotions connect with events, objects and their movement over time. Becoming emotional involves becoming part "of an inclusive and enduring situation that involves concern for objects and issues." (p.42). In sharing our data of Lila's emotional trajectory through movie strip style still images taken from video we hope to illuminate the way Lila's mathematical learning experience is indeed characterised by engagement and movement around mathematical objects. Lila's experience is driven by the intertwined emotional and cognitive trajectories of cumulation, tension, anticipation, and fulfilment shaped by her and her mother's ways of being

and interacting in each other's physical presence (Jordan & Henderson, 1995). Fuller and Weizman's (2021) concept of aestheticizing pushes us to explore "new conditions of knowing, seeing and doing" (p. 111). Evidence of learning is not solely defined by the facts that are presented, but also by how those facts are communicated and subsequently experienced by others. For example, Günes et al. (2024) argue for aestheticising mathematics education research pushing us to extend our lens beyond mathematics knowing to investigating the 'mathematical sensorium'. They propose using re-enactments as powerful research methods. Those at MERGA 46 will recall how Sinclair (2024) had us re-enact what we witnessed the child do in the videos. This stimulated our sensual knowing of what the child was doing/experiencing. Here, we propose (and demonstrate through sharing data from a single opportunity sample) aestheticizing the reading of mathematics education research through sharing movie type strips of learner expressions across a mathematics learning event. See Ferrara and Ferrari (2025) for their methodological contribution of ways diagrams can stimulate aesthetic and affective mathematical engagement while positioning learners at the centre of the mathematical activity.

In revisiting our data analysis, we use Sinclair's (2024) notion of embodied validity that builds on Lather's (1993) post-structural notion of voluptuous situated validity. This validity provides space for an "embodied positionality and a tentativeness which leaves space for others to enter" where authority "comes from engagement and reflexivity" (Lather, 1993, p37). Embodied validity has implications for how we interpret and share data (Sinclair, 2024a). We illuminate this in terms of how the notion of embodied validity has guided our re-interpretation of the data. By deliberately including a series of images that capture the learner's shifting expressions, we invite readers to engage with her cognitive and emotional trajectories. The visual elements further reinforce the validity of our claims regarding what constitutes a mathematical learning experience. We are thus working with the assumption that our readers 'seeing' an image that clearly captures emotional intensity will have a sensory experience linked to that 'seeing'. In the same way that journalists use emotive images to capture the human experience of various situations (joyous and desperate) based on the assumption that the viewer will have an emotive sensory reaction to the experience, we include images we consider can be reasonably assumed to be self-evident of an emotion (or range of emotions) and will likely stimulate a sensory response in the reader viewing the data. We work with this pragmatic assumption while noting the research linking exposure to visual images to emotional responses (e.g., Nanda et al., 2012) and detailing neurological mechanisms evoked when humans view emotive images (e.g., Fried et al., 1997). We further acknowledge the interdisciplinary research that has focused on interaction analysis based on multiple viewings of audiovisual recordings (e.g., Jordan & Henderson, 1995) and informs our (and Sinclair & colleagues) approach.

Method

We began our re-analysis focusing on part of Lila's mathematical learning experience from her discovery of the 3, 6, 9 pattern on the remote to her progression in counting by threes up to 18. We divided this learning experience into scenes, indicated by continuity/cumulation, tension, anticipation, and fulfilment. Following discussion and identification of these characteristics, eight scenes were identified. Every scene began with some prompting, requiring engagement toward fulfilment. Each scene ended with an indicator of fulfilment (even when the fulfilment of the experience was mathematically incorrect). One or two four-frame 'video strips' were constructed to capture the emotional trajectory of Lila across each scene of mathematical learning experience. The still images were selected and cut from the video excerpt along with the time stamp for the image. In some cases, two images are included with the same time stamp because several images can be selected from any single second of video. In cases where emotional shifts were visible within a second these were included and placed sequentially

with the same time stamp. Perhaps better software could create more refined time stamps, but we did not think this necessary for our purpose. Words spoken at the second of the image were included along with a brief comment about what was happening where appropriate. Continuity, anticipation, cumulation, tensions, fulfilment and emotive descriptors are noted across images.
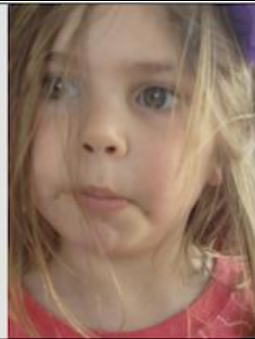
It is beyond the scope of this paper to discuss how the ZPD is stimulated and sustained equally by Lila's emotional and cognitive trajectories, or how her mother's mediation is equally prompted by Lila's emotions (seen in her expressions and tone and volume of her voice) as by what Lila says and shows on the remote (see Abtahi and Graven, in press). Here we analyse Lila's emotional trajectories across three scenes (5, 6, and 8) by sharing 'video strip' images to engage readers' sensory experience of 'reading' (and seeing images of) the learning event and thus to establish embodied validity to support our analysis. While not claiming that video strip type images of children's unfolding emotive expressions is new to mathematics education, we expect that many authors, like us, may have excluded such images for various reasons (e.g., prioritizing cognitive aspects, maintaining an exclusive focus on what is said as a marker of rigor, concerns over image quality for publication, anonymity considerations, or space limitations). Our aim is to provide sufficient sensory data to enable us and readers to consider our earlier stated methodologically driven research questions.

Analysis and Communication of Lila's Emotional Trajectory Data

(00-00:44) - Scenes 1 and 2 involved Lila responding to her mother's prompts to show her how she worked out counting in threes. Lila fulfils each scene in which Mellony requests 'show me'. In Scene 1 the experience is fulfilled as she gestures with her finger across the three rows saying 'cause everyone is three'. Scene 2 is fulfilled when she responds to 'so show me how you are counting' with gesturing across the four rows of three buttons emphasizing the 3, 6, and 9 and continues to the three non-numbered buttons—saying 12 on the last button. Scenes 3 and 4 were fulfilled when Lila responded to Mellony's questions about how she knows its 12 and why she thinks it is counting in threes, respectively. We begin our analysis from Scene 5 where Mellony asks "and what do you think comes after 12 if we are counting in threes?" The question invokes continuity and is the start of accumulation towards the fulfilment of a new task. Lila responds by spending the next 18 seconds (00:49–1:07) mouthing quietly 1, 2, 3, ….11, 12, 13. The video strips below show images across this time that indicate the cumulation, tension, anticipation and fulfilment (even while 13 is incorrect if counting in threes).

Figure 2

Video Strip Scene 5

5-a) 00:49 **continuity,** listening to the question *willingness to engage*	5-b) 00:49 **anticipation**, idea for a way towards fulfilment *willingness to engage*	5-c) 00:51 **cumulation,** begins mouthing 1, 2, *willingness to engage*	5-d) 00:55 **continuity/ cumulation,** mouthing numbers *willingness to engage*

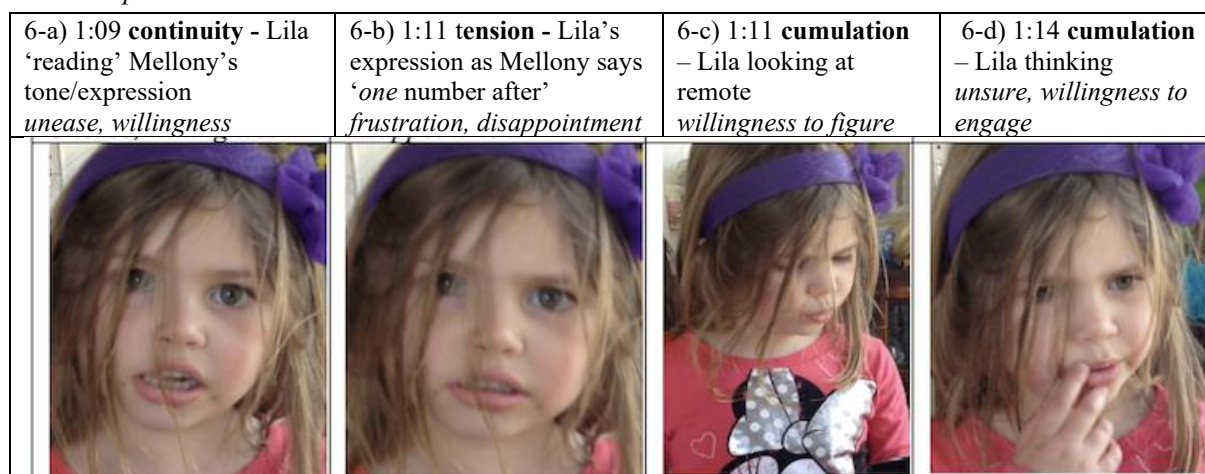| 5-e) 00:58 **cumulation,** still mouthing *willingness to engage*	5-f) 1:05 **cumulation,** quietly audible '13' *willingness to engage*	5-g) 1:06 **fulfilment,** '13' loud, declarative *confident, happy*	5-h) 1:07 **fulfilment** anticipates response *happy, hopeful*

Unpacking Lila's emotional trajectory we see in the two 4-frame video strips Lila's willingness to engage by listening (image 5-a) enabled continuity and anticipation of a response (image 5-b) followed by continuity/accumulation (image 5-c-f) towards fulfilment (image 5-g-h) where she happily and confidently restates 13 as the answer and looks to her mother hoping for (anticipating) a positive response. We consider that these strips provide indicators of the way in which this mathematical experience unfolded for Lila and the way in which her emotions are integral to this mathematical learning experience. We expect the reader to experience some kind of sensory reaction to viewing these images while acknowledging that individual responses may vary. Embodied validity lies in the degree to which readers and our interpretations of the images' characteristics and emotions resonate. Lila's anticipation of a response (5-h) shows willingness to continue to engage around this. She has not shown that she wants to leave. This emotional cue leads Mellony to note the logic of her answer '13' (indeed Lila counted from 1-13 effectively) and nudge her to finding the next number when counting *in threes*, saying at the start of Scene 6: "13 is the number after 12. That is right, but that is one number after 12, what if you were counting in threes?

Mellony's prompt invokes continuity and the start of accumulation towards another fulfilment of the same task. The video strips below show new sets of images across the time that indicate the Lila's emotional trajectory: cumulation, tension, anticipation and fulfilment.

Figure 3

Video strips Scene 6

6-a) 1:09 **continuity** - Lila 'reading' Mellony's tone/expression *unease, willingness*	6-b) 1:11 **tension** - Lila's expression as Mellony says '*one* number after' *frustration, disappointment*	6-c) 1:11 **cumulation** – Lila looking at remote *willingness to figure*	6-d) 1:14 **cumulation** – Lila thinking *unsure, willingness to engage*

We see in this scene Lila's *unease* (image 6-a) along with continued *willingness* to engage. She maintains eye contact and does not walk off. Lila experiences tension in being unsure

(appearing frustrated/disappointed) when Mellony says 13 is 'one number after 12' (image 6-b). The tension is followed by continuity/accumulation (image 6c-d) towards some kind of fulfilment. Lila is unsure but engaged (image 6-d). Fulfilment comes when at 1:15 Lila says quietly and slowly 'I'm not sure' (see second line drawing in Figure 1). Again, in this scene, we see that emotions are an integral part of Lila's mathematical learning experience. In Scene 7 Mellony suggests using the remote. Lila responds that there are no more buttons beyond the three under 7, 8, 9, labelled 'menu' '0' and 'help'. At the start of Scene 8 Mellony asks: Can we pretend that there are three maybe?" Mellony points to the remote as she prompts Lila to reintegrate the TV remote into the mathematical learning experience, suggesting 'pretending' there are three. This fosters continuity and further carries anticipation for accumulation toward a newer (and more mathematically sound) fulfilment. Mellony's inquiry is guided by her perception of Lila's willingness to engageme captured in her expressions and body language.

Figure 4

Video strips Scene 8

8-a) 1:24 **cumulation** uses remote, moves to place middle fingers over the 1,2,3 buttons *willingness, tension*	8-b) 1:31 **cumulation,** soft um while three fingers are on 1,2,3 *willingness, unsure*	8-c) 1:37 **cumulation,** says 'twelve' as three fingers are on buttons 7,8,9 *willingness*	8-d) 1:42 **cumulation, anticipation,** mouths 13,14,15 faintly audible, fingers aside remote, *pleased*

8-e) 1:42 **fulfilment,** repeats 'fif' jumping up off screen (hence blurred) *excited*	8-f) 1:43 **fulfilment,** says 'teen' landing from jump *excited, confident*	8-g) 1:43 **fulfilment,** says 'fifteen' *confident, happy and proud*	8-h) 1:44 **fulfilment,** looking at mother while she says: 'My word my angel, that is brilliant'. *confident ,happy, proud*

In Scene 8, we observe Lila's willingness and engagement intertwined with moments of uncertainty (images 8-a and 8-b). Cumulation and continuity unfold as she focuses on the remote and moves her fingers on them. Her wanting to complete the task culminates in a breakthrough, marked by a radiant smile (image 8-d). Fulfilment becomes strikingly apparent as Lila, brimming with pride, nearly leaps off the screen (image 8-e), triumphantly declaring 15 as the next number (images 8-f to 8-h). Again, after the scene's fulfilment, Lila stays, maintaining eye contact, showing willingness to continue engaging. This leads Mellony to ask what comes after 15 with new scenes similarly reaching fulfilment with Lila's answer of 18.

Discussion

We have shown the use of sequential 4-frame stills cut from video to create 'video strips' of evolving expressions and body language across a series of linked learning experiences. Images are time stamped and categorised as an indication of continuity/cumulation, anticipation, tension, and or fulfilment along with a listing of the emotion/s visible—interspersed with transcripts of what is said and an explanation of the episode. We propose this as a productive way to analyse and interpret data more fully (than focusing only on words and actions as evidence of cognitive drivers) and that these provide the reader a broader experience of the data. Indeed, across these scenes few words are spoken and sharing the images is to engage the reader in an experience that highlights how emotional trajectories and cognitive drivers are inseparably intertwined. We have taken the images shared as self-evident indicators of certain emotions. We concede that viewers presented single images would likely give different, though synergistic, descriptions of the emotions visible (e.g., for 8-a 'pleased', 'assured', 'excited'), raising the question of how closely our descriptions of Lila's emotions must align with the readers'. This is a complex issue requiring further investigation. However, we argue that the embodied validity emerges not in the reader's confirmation or agreement with emotional labels for each image but with the emotional categorisation—as a whole.

We argue that separating the analysis of emotional trajectories from the cognitive drivers of learning (as we did earlier) is problematic on theoretical, methodological, and pragmatic levels. Theoretically, the separation disregards the central role of emotion in learning events. We have shown here how emotions are not merely peripheral to cognitive processes; rather, they actively shape and drive learning interactions. Our earlier cognitive focus overlooked how Mellony's choices were mediated not only by Lila's verbal expressions but also by witnessing and experiencing the full spectrum of her emotional trajectory. The interplay between emotion and cognition is fundamental, as emotional responses can reinforce, hinder, or redirect cognitive engagement. Methodologically, separating these aspects fails to account for the ways our observation and experience of viewing the video and its still images—capturing Lila's emotions—shaped our interpretation of her voice and gestures. Treating cognition and emotion as distinct risks misrepresenting the holistic nature of a learning process. Further it constrains our ability to strengthen the validity of our claims about learning events. Without the inclusion of images that serve as 'self-evident' indicators of emotional influences, we miss an opportunity to provide readers with a more embodied and immersive experience, allowing them to engage more fully with the affective dimensions of the learning process. Pragmatically, separating these aspects is problematic because if we render invisible this aspect of learning in our writing and our work with prospective and in-service teachers, we inadvertently send messages that children's emotions do not need consideration when mediating mathematical learning.

This begs the question of why we have not focused on learner emotive expressions and body language in our earlier writing. As noted, we have struggled to find appropriate theoretical tools to analyse emotional trajectories. Sinclair's recent work, however, introduced us to a range of valuable theoretical perspectives that support our efforts in addressing this gap. However logistical issues also threaten to hamper our future intentions to bring emotional trajectories centre stage in our analysis of mathematical learning events. Beyond the issue of the quality of images that journals may require is the issue of abandoning anonymity for the child in the study. If we consider children's expressions important to our analysis and to establishing embodied validity, then blocking out faces or eyes would defeat our aim as it would weaken the sensory experience of the reader. In the first author's institution many research proposals indicate they will not capture images of learners faces and will only video their hands, what they write, draw etc. This is a way to address the anonymity and vulnerability of the learners and can increase the likelihood of ethical clearance being granted. We argue that much is however lost when we

avoid capturing and communicating images of learners' emotional trajectories guiding learning. We lose sharing a richer, more human, understanding of the nature of learning interactions among participants and the central role of emotions in guiding mediation with our field. However, drawing on the adage across multiple languages that "a picture is worth 1,000 words"—meaning multiple ideas can be succinctly communicated in an image saving lengthy wordy descriptions—we can enrich readers' experiences. We propose this adage be increasingly *exploited* in support of embodied validity and readers' aesthetic experiences.

Concluding Remarks

In this paper we revisited our earlier analysis (Abtahi et al. 2017) of a learning event where we looked at an entirety of a learning experience, through what was said. Here, we highlighted that emotions are not secondary to learning; they actively shape interactions and decision-making. Ignoring emotions in video analysis not only reduces the depth and validity of our interpretations but risks sending implicit messages that children's emotional experiences are at best secondary and at worst irrelevant in mathematical learning. We understand that ethical restrictions related to anonymity limit the ability to analyse and share emotional expressions effectively. Despite these challenges, we argue that incorporating visual data of human expressions into research writing enriches our understanding by providing a more humanized and embodied perspective on learning. The integration of emotional and cognitive analysis offers a more nuanced and holistic view of learning interactions, enabling researchers and educators to recognize the deeply interconnected nature of emotion and cognition. Embracing this perspective, our field can move toward a more comprehensive understanding of learning.

Ethics Statement

This paper involves re-analysis of already published data. This said, Lila, now an adult, read the paper and gave consent for the inclusion of her images and data in the paper.

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