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Research Article

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Making Visible: Right-To-Education Fifth Grade Children Redirect Teacher Professional Development for Success

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Abstract

This study describes an intervention that was delivered on-line from Seattle in the USA to an E-Stream grade five classroom of boys and girls in Bangalore, India. E-Stream children were Right to Education learners who, because of their humble background and familial poverty were assigned to this school by State Rules. Unprepared for school, these children came with learning deficiencies and learning gaps that consigned them to special provision for intervention. Teachers who were trained in typical 'Normal School' training programs expressed ominous portent at the poor levels of social and emotional engagement that included occurrences of targeted choking, bullying, and other aggressive behaviors. Intervention participants were incumbent educators—teachers (N=9) whose command of English was subpar to their native mother tongue that included at least four other languages (Kannada, Hindi, Malayalam, Telegu). Their longevity (years of teaching) at this school ranged between 4 to 28 years, (average=18). Each of the teachers taught different subjects within Language, Mathematics, Sciences, and Writing. Both the children and the teachers were aware of the children's status as having been labeled E-Stream—bottommost of the learning level at any school. We used a mixed method that nested categorical quantitative data within a comprehensive qualitative corpus of media that included transripts of video, images, memos and field notes. The study was operationalized into three phases: Phase 1 describes the learning system prior to intervention; Phase 2 describes the intervention which we refer to as a precipitous dive into the deep end of the cognitive pool; Phase 3 describes teachers' implementation or failure to implement cognitive methods. We present findings that highlight perceived shifts in both practice and mental models for teachers that profoundly impacted the children also. Recommendations and future studies are provided.

Keywords: Streaming, cognitive deep end, making visible, mental models, metacognition.

1. Introduction

The Right to Education (RTE) Act of 2009 guarantees free and compulsory education for children between 6 and 14 years across India. A key provision mandates private, unaided schools to allocate 25% of their seats to children from disadvantaged and economically weaker family settings at the entry level. Local implementation, however, indicates how some states challenge this Child Right. For instance, the State of Karnataka (where the school in this study is located) has interpreted and applied a different criterion through local legislation that exempt some of the rules for implementing the Act. A new procedural precept, *Karnataka Right of Children to Free and Compulsory Education Rules*, which was advanced in 2012, resulted in significant drop in admissions in Bangalor. Nevertheless, for this study 23 children were culled for the E-Stream program in fifth grade. Intake testing highlighted a pernicious weakness in reading and writing in the English language. Since English is the *lingua franca* for the school, this set the children in E-Stream up for failure from the outset.

Streaming is a prominent feature of this school's stratification system—aligning precisely with incoming RTE students who, because of their social and economic status, are ill-prepared for the exigencies of high stakes standardized testing regimens. Often referred to in other terms (e.g., rigid ability grouping) this form of organizing learning systems has been shown to delivery significant negative outcomes for children's life trajectories. In a recent UK study at the London Institute of Education, the following result was significant to us, as we undertook a similar intervention. *"Children placed in the bottom stream did worse in maths and reading in key stage one assessments than similar children in mixed-ability classes, even after adjusting for social and parental background. But those in the top stream did better than their peers in mixed-ability classes"* [1].

Historically streaming—the practice of grouping students by perceived academic ability into separate classes for all subjects—was a common feature of the British education system up to the 1960s and was subsequently, implemented in colonial

outposts, with questionable outcomes socially, academically, and economically—including in India [2,3].

Educators who find themselves saddled with post-colonial residual methods and mindsets call for reform with powerful words, even if reforms have failed for decades to achieve the stated lofty goals. In Europe, for instance, a leading researcher at the *Economic and Social Research Institute* (ESRI) pleads for reform, stating that *"schools can make a crucial difference to the educational development of their students by moving away from rigid ability grouping, by promoting a positive school climate, and by making the classroom an engaging place for young people"* [4]. In this study, we focus on verbiage also, referring to the proposed paradigm shift that we sought to instantiate, as a dive into the 'deep end of the cognitive pool'. Working in a school system that perpetuates a five-way stratification of children's ability based on socio-economic status, religion, fluency with English language, and academic success, appears to conform readily to Albert Memmi's conception of the colonizer and the colonized. He sums up the ambiguous situation that educators in our study find themselves having inherited colonial stratified systems that define their work each day. For them, *"The colonial situation thrusts economic, political, and affective facts upon every colonizer against which he may rebel, but which he can never abandon. These facts form the very essence of the colonial system, and soon the colonialist realizes his own ambiguity"* [5]. This precarious ambiguity is borne out in the educational endeavor of this school since teachers, as *de facto* Colonizers, idolize their own culture and degrade the colonized (RTE children's) culture, as colonization itself valorizes racism as both a foundational premise and the ultimate expression of its power [5]. The view from inside is often invisible to the executors. However, as Wilkerson points out in her seminal writings on caste systems, *"ignorance is no protection from the consequences of inaction"* [6]. Further, there is strong evidence that prescriptive asymmetric methodologies that focused on rewards and punishments unwittingly caused a degree of learned helplessness to taint the children's learning capacity [7].

Beyond ranking children into homogeneous groups categorized by ability, teachers in Bangalore schools—just like teachers in other countries—are guided by a prevailing and persistent Lortie Effect. Education is a profession, unlike all others, where aspiring new professionals are prone to high degrees of preconception and misconception in their acquisition of licenses for work. The *apprenticeship of observation*[1] phenomenon [8] tends to limit how novice teachers perceive their roles in classrooms. Most arrive at teacher training courses with experiences that color their understanding of what it means to be a teacher. For instance, having spent thousands of hours as schoolchildren observing and evaluating other teachers in action, they supposedly understand how learning happens. This rarely occurs in other professions. Children do not typically spend thousands of hours observing lawyers, nurses, or aerospace engineers at work. One of the consequences of this apprenticeship period is that, whereas people entering other professions are more likely to be aware of the limitations of their knowledge, student teachers may fail to realize that the aspects of teaching which they perceived as students represented only a partial view of the teacher's job.

Upon initiating this research study, we observed teaching behaviors that emanated not from scientific principles of how children learn or how the human brain works, but instead from many years of intuition and imitation. This traditional feature of teacher practice aligns with Lortie's 'Apprenticeship of Observation' model of schools and knowledge transmission and, in this case, appears to be further complicated by endemic features of parental comprehension regarding how they should interact, respond, and perceive themselves, others, and the environment [8]. For these teachers, methods were seen as ready-made recipes for action and interpretation which, requiring neither testing nor analysis, predictably promise familiar, safe results [9]. The overriding model for instruction aligned with research that highlights default options; a set of what was considered to be 'tried and tested' strategies which they can revert to in times of indecision [10]. Contrast these mindsets with the paradigm shift that was required upon initiation into this research program—children's brains contain approximately one-hundred-billion neurons, separated by one-hundred-billion synapses, each synapse is site of approximately ten thousand highly meaningful activations that affect learning. Simple math indicates that each child has trillions upon trillions of potentials [11,12,13].

A broad understanding that 'structure' underpins 'function' is well established in neuroscience. This knowledge was a high-level driver for the research in this study. We were aware that educators in Bangalore had no knowledge of the impact of this kind of thinking. Could educators who focused on neural structures rather than on memorizing content achieve both? Could teachers have meaningful success through growing white matter connections in areas of the cortical tissue associated with critical thinking by adjusting the learning environment so that children were invited to make mistakes in reading, writing, or mathematics.

[1] *Apprenticeship of Observation* was a term coined by Dan Lortie in his book, *Schoolteacher: A Sociological Study* (1975) which describes an atypical model of learning that was largely responsible for preconceptions and misconceptions that pre-service student teachers imagine about teaching.

1.1. Operationalize in Three Phases

Phase One highlights the learning situation that precipitated the study and is clearly defined as the months after school begun (July 2023) through the end of first term (November 2023). Teachers were overwhelmed by persistent challenges that stemmed from E-Stream learners' inability to learn in all subjects. When matters in the classroom deteriorated to a point where aggressive behaviors caused widespread alarm among staff, where the safety of children was called into play, something had to be done. Not just anything something—something different that had the potential to affect dramatic change. After all, half the school year was already expended, and time was running out for these children. As an example of the chaos and lack of coordinated effectual practice, we outline the very real fear that one of the children might do a serious injury to a peer during any ordinary day in the classroom. Example of the child referred to as Cee Zee (anonymous) and several dangerous choking incidents are described by his teacher[2]. Beginning of year tests highlighted serious deficiencies in reading and writing for E-Stream children who were seen as high-risk of failing—literacy skills that were essential for success in school [14,15]) and needed in order to advance to the next grade. By the time the intervention begun (half-way through the academic year in Bangalore) matters had deteriorated since some children who were programed to fail in a behaviorist methodology [16,17] reacted with aggressive outbursts that put themselves and their peers in danger.

Phase Two marks the beginning of the intervention which coincided with the second term (December 2023) and ended when the professional development was delivered (End of January 2023). This is what we refer to as the dive into the deep end of the cognitive pool. For the nine teachers involved in this study, everything about human brain and subsequent neuroscience of learning was new to them. Traditional teacher professional development in Indian educational institutions was typical of teacher training course in many places across the globe. Focus was on behavior, solutions to unexpected behavior derived from an understanding of deficits that linked bad outcomes to bad children and good outcomes to good children. An overriding predilection with a deficit model meant that these teachers maintained alarming assumptions that E-Stream students from low-income household, where parents had a poor command of English, would not understand certain course materials due to a lack of exposure to "rigorous" curricula [18,19,20]). By contrast, the deep end of the cognitive pool refers to a sudden immersive practice that forced a metacognitive introspection [21,22]) of methods and practice [23]. In such a program of intervention, intentionality with respect to vocabulary was designed to change mental models [24,25] about learning when perspectives that focused on white matter structures [26] and electro-chemical activations [27] over perceptions based on compliance or At-Risk encounters [28]. In this new vision, behavior was merely a communication that pointed to a neural substrate which helped illuminate both the problem and the solution [21].

Phase Three accounts for teachers' implementation of the intervention processes and practice that demonstrate a required shift from a behaviorist paradigm to a cognitivist paradigm in the classroom. In particular, each weekly encounter was captured in a metacognitive moment where teachers made visible their thinking regarding the content and implications in the classroom during implementation. After appropriate sleep, [29] each teacher was asked to explain their reasoning in a rich affective engagement that enhances long term potentiation and adjusts their learning brain accordingly [30,31].

1.2. Neural Substrates of Learning

The Pygmalion Effect in the classroom describes a phenomenon whereby higher expectations lead to increased performance. Rosenthal's description is as meaningful today as it was 60 years ago [32], since implicit bias [33] pervades teachers' lived experience. A corollary of the Pygmalion Effect is the Golem Effect, in which low expectations lead to a decrease in performance. Both effects can appear as self-fulfilling prophecies.

Classrooms designed with brain-based methodologies in mind are very different to traditional classrooms that represent Lortie and/or Rosenthal's unconscious designs [16]. In a traditional setting, lessons are focused on academic outcomes based on content that is measured using high stakes assessment tools. It is rare to hear teachers discussing or planning to architect a child's brain [34]. For instance, embodied cognition in lesson plans that include kinesthetic activations and, which focus on growing white matter structures pertaining to focus and attention [35], looks very different from planning sessions for 'content' lessons [17,36]). Most teachers inherited a fixed mindset by sheer dint of long years in immersive observation [37]). By contrast, Neural Enrichment educators portray embodied cognitive thinking—it's not about content; it's about architecting children's learning brains [38].

[2] Teacher account of aggressive behavior: "When there was no teacher in the class during the transition time, Cee Zee took the jamkana—the short cotton carpet that was spread on the floor—and put it on a boy's head. Two other boys joined Cee Zee and ganged up on this boy beating him very badly. The moment I stepped inside, I saw this boy crying terribly. He was so frightened and was gasping for breath as if he was choking. Immediately, I sent him to the washroom, asked him to wash his face, gave him some water, and tried to console him. He is usually like this. He keeps troubling others; he is a very troublesome boy. That day also, I had already made him sit separately in the classroom because of his behavior." (Source: E-Stream 2024)

In this study, new training shifted teacher's thinking in relation to brain and learning [17]. The research team sought to understand this newfound intentionality and mindset. These results align with a corpus of educational literature that documents grave outcomes for life trajectories because of high-risk children's impoverished opportunity through increased achievement gaps [39,40]. Such opportunity gaps are apparent with factors like race, gender, ethnicity, socioeconomic status, and English Language proficiency contribute to lower educational accomplishment [41]. In this study, other factors were also at play. These included poor parental education and home life stresses caused by lack of proficiency with English language [42,43], as well as issues that sprang from the COVID-19 pandemic [44,45] and included isolation, masking, and social distancing.

Educators in the US had documented similar classroom sized, individual and group improvements that looked similar, through poverty [17]), behavior [16], opportunity [46], and achievement [47]. The children in this study were thus, participants in a novel teaching methodology emphasizing a brain-based pedagogic model [21].

1.3. Theoretical Framework

The overarching theoretical framework for this study draws on the work of critical discourse analysis that illuminates covert curriculums as well as implicit mentalistic biases that are endemic to school systems everywhere. For instance, in a postmodern Foucauldian tradition of juxtaposing asymmetries like power, knowledge and liberty as a form of social control we contrast Phase One educator mindset with emergent neuro and brain-based expressions that are informed by thinking from the deep end of the cognitive pool (Phase Two). At the intersection of behaviorist thinking where teachers indicate agreement with the notion that: Schools serve the same social functions as prisons and mental institutions—to define, classify, control, and regulate people [48], with post 'decade-of-the-brain' thinking that refines learning as engineering white matter circuitry: neuronal recycling, which involves repurposing and adapting pre-existing neural circuits, a process enabled in part by the plasticity of white matter [49].

1.4. Definition

For this study, discourse is defined as communication, system of thought or language that constructs a particular world experience.

2. Research Question

The design team focused on one overarching question. "How does a pedagogic learning sciences construct—*Making Visible*—affect a paradigm shift for teachers in mainstream schools in India?"

The working definition for this 'Making Visible' construct is coded: *Effective teaching requires that the teacher makes visible what the children know, don't know, or could know*.

This question was operationalized by investigating the impact of the practice of unpacking teacher discourse pertaining to the coded construct 'Making visible' as it applied to their interpretation of how schools work and how children learn.

2.1. Unit of Analysis

For this study, it quickly became clear that given the late start to the intervention, there wasn't enough time to introduce a new method first and then implement it. The project is therefore likened to a popular metaphor used in similar contexts to describe the challenging task of developing something complex while it is already in motion—building a plane as we were flying it. While this is a difficult situation, it is not an uncommon challenge for innovative teams who undertake originality in various similar and disparate fields [50,51,52].

The unit of analysis emerged over time, from discussions and interactions online with the incumbent teachers who found themselves daily in the deep end of the cognitive pool. In other words, it became clear that their efforts at sense-making in relation to emergent constructs and terminology that were not only novel, but specifically foreign, highlighted the verbiage that they used in their daily LTP summaries. LTP, an acronym for Long Term Potentiation, emerged as one of the first neural procedures that they were forced to come to grips with—the notion that educators (including themselves) could cause physical change, a structural rewiring of the learning brain that persisted with purposeful activation. The problem was not simply novel and foreign words; words like fusiform gyrus, hippocampal synaptogenesis were not only Latin derivations, but they were also not even in the same cultural provenance as their native linguistic etymologies like Sanskrit or Hindi.

The weekly LTP thus acted as a mirror for the research team, with a view into emergent thinking of the educators who were making visible how they made sense of new terminology and challenging constructs so they could be implemented with rigor. The unit of analysis was therefore the interpretation of their efforts at *sense-making* in relation to novel words, concepts, neuroscientific processes, cognitive flexibility settings and events, and embodied cognition activities for and with the children in the classroom.

3. Methodology

When children are not able to engage in learning systems that are age-appropriate and necessary for them to move up to the next grade level it is usual to use special interventions to shore up gaps and to support struggling individuals. This study comprised a data collection team in a distributed (online) vault system based 11.5 hours behind the E-Stream learners with one 'feet-on-the-ground' implementation member in Bangalore who interacted daily with the 9 teachers. Once a week, the entire cohort came together online to advance the (i) professional development, (ii) discuss what was or was not working, and (iii) solidify the data collection process. In Figure 1. *E-Stream*

Teachers Paradigm Shift Design Block: Phase 1, we highlight the visual that triggers the construct of making visible what a paradigm shift from behaviour to cognitive approaches to learning might look like [23]. Each of the three Axes referred to a learning construct that had deep meaning from a brain-based perspective in the classroom. The X Axis focused on *Mindset* delineating a shift from *Fixed* to *Growth* [53]. The Y Axis focused on *Expertise* delineating a shift from *Routine* to *Adaptive* [54]. The Z Axis focused on *Motivation* delineating a shift from *Extrinsic* to *Intrinsic [55]*.

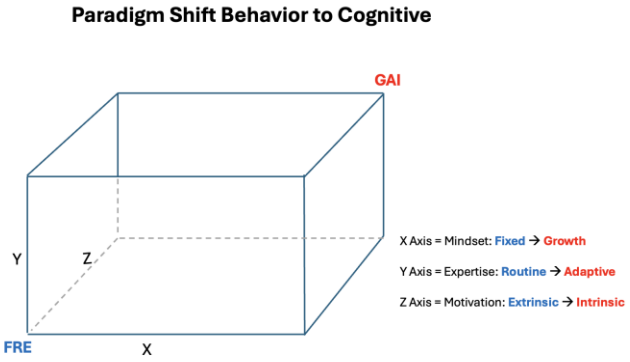

Figure 1: *E-Stream Teachers Paradigm Shift Design Block: Phase 1.*

As described earlier, Phase Two is best described as 'deep end of the cognitive pool' for the nine teachers who were experiencing for the first time, an immersion into a novel way of interpreting the cognitive revolution in practice [56] while making sense of brain-based methodologies like disequilibrium and embodied cognition [57,58], and exercises that increased working memory [59,60].

3.1. Population Sample

The study took place within a school system in Bangalore. It was a classic example of an opportunistic quasi-experimental design reflecting school life in a streaming (affinity grouping based on perceived academic readiness or ability) post-colonial environment [61].

The sample (N=23) comprised fifth grade (average age 12.7 years) boys and girls who spoke English as a second language and whose mother tongues include 5 other local languages that are common across the Indian State of Karnataka. While these children had attained a working, lived experience in their mother tongue, all school operations pertaining to the acquisition of new knowledge was, by requirement, delivered via the English (second) language. For instance, Tables 1a and 1b below *Scores 5th Grade Summary* highlight the difference in scores for the 2nd (midyear) test between children who were in Five A-Stream and the children in our study who were in Five E-Stream. From that point of view, it was perceived that most of the lagging that was detailed by the teachers who ranked them based on the results of intake test instruments attributed their deficiencies to language capabilities. It therefore, became a priority for the research cohort to focus the intervention on architecting white matter structures in areas of the brain that consolidated deep understanding and retrieval fluency on phonological capacity [14,62] and visual-spatial processing [63,64].

Table 1a*: Scores 5^{A} Grade Summary*

Subjectwise Assessment Report -AY-2023-2024							
Consolidated Sheet - PT 2							
Class: V A							
English	Samskruta	Kannada	Hindi	Math	Science	S.Sci	Comp
32	40	40	39.5	38	31.5	36	45.5
35.5	40	40	39.5	39	38.5	38.5	48.5
35.5	40	39	39.5	40	38	39.5	50
27.5	32	32	39.5	32	33.5	36	35.5
12	21	18	16	23	28.5	19.5	35.5
10.5	15.5	20.5	27	10	12	12.5	27
18	38.5	29	39	30.5	32.5	30.5	43
24	37.5	36	38.5	29.5	32.5	33	43.5
32	39.5	37	39.5	35.5	37.5	36.5	45.5
32	38.5	40	39.5	39	39	38	49

Table 1b: *Scores 5^{E} Grade Summary*

Consolidated Sheet -PT 2							
Class:V E							
English	Samskrut	Kannada	Hindi	Math	Science	S.Sci	Comp.Sc
40	40	40	40	40	40	40	50
4	8.0	6	14.5	15.5	9	0.5	24.5
1	4.5	0.5	1	7.5	2.5	0	25.5
1	6.5	1	4	7	4	0	23
0	5.5	2	1	3	2	0	23
9.5	20.5	18	19.5	26	11	11	26.5
10.5	28.0	20	28	15	18.5	5	29
5.5	14.0	8	14.5	15	12	3	25.5
5	7.5	4	17.5	18.5	8	4	26
15	25.0	26	24	23.5	18.5	13.5	27.5
10.5	10.0	14	15	20	17.5	12.5	31.5

Data were collected via instruments that reflected the complexity of the study in terms of teacher professional development online exposition and implementation of methods and practices daily in classrooms using videography, zoom recordings, interviews of children and teachers, observations and field notes. These data were collected and backed up in an online (and physical) vault by the team in India and shared with the team in Seattle. Transcripts were created, coding carried out and processed via Dedoose (2025) online platform.

3.2. Mixed Methods

The research team adopted a nested concurrent research design to highlight strengths of this learning sciences study [65]. It combines qualitative and quantitative data collection and analysis as shown by the high-level schematic [66] in Figure 1: *Mixed Method Model*. It depicts the two types of data represented in this mixed method study. Quantitative data relating to attendance, gender, age, and pre- and post-scores detailing literacy values are embedded within a qualitative corpus of interviews, video transcripts, work samples, photographs, and field notes.

We chose a coding software platform (Dedoose 2024), which facilitated focused and safe communication channels while data (e.g., transcripts, audio files etc.) were processed, coded and analyzed. The team began with an axial coding review, that surfaced connections between related codes [67]. When patterns and programmatic outcomes emerged, team members switched to selective coding techniques and focused on categories that alerted theoretical deduction.

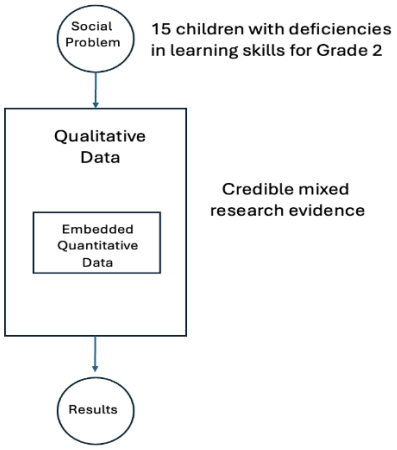

Figure 2: *Mixed Method Model*

3.3. Grounded theory

Grounded theory [68] was used to explain apparent changes over time and involved both inductive and deductive team discussions. This methodology offered sense-making measures to protect the integrity of the data, teaching methods, and personal views of teachers and parents. Daily team discussions ensured that interpretation was valid and reliable. These discussions were designed to avoid biases, prejudices, and stereotypical perspectives [69]. Theoretical explanations were grounded in empirical reality to reflect relatable and valid data [70].

4. Results

Bangalore is 11.5 hours ahead of Seattle. Late evening professional development connected with next morning teachers before children showed up in their classrooms. This was not always convenient because school day typically started with assembly, prayer, meditation and other cultural and local customs. Beyond managing the necessity to accommodate a working environment with everyday challenges, teachers were tasked to attend weekly trainings via Zoom classes, that usurped 30 minutes of morning time. In addition, they also had to meet daily with the 'feet-on-the-ground' team in Bangalore to insure rigor in implementation. Teachers were introduced to cognitive

flexibility routines that were designed to architect the learning brain so that children would find themselves in a very different learning environment where affordances like autonomy, mastery and purpose were valued.

Results are shared below in alignment with the evolution of the intervention: *Phase One:* Baseline metric that outlines teacher mental models prior to the 'deep end' immersion; *Phase Two:* Sensitization of staff in a novel model, which required the abandonment of rewards and punishments and the embracing of a cognitive motif for teaching and learning; and *Phase Three:* Sense-Making of the paradigm shift from behaviourism to cognitivism as expressed in verbiage, body language, embodied cognition, and deep understanding of the procedures that were implemented.

4.1. Phase One

As expected, findings highlight in *Phase One* that teachers' discourse illuminates an overriding entrenched thinking pertaining to children's behaviour, which forefronts shared mental models that reflected their teacher training from earlier university courses about how schools work and how children learn. We illustrate this finding by cataloging the teachers thinking, actions and apparent mental models and aligning them with a tripart paradigm shift on three planes at once.

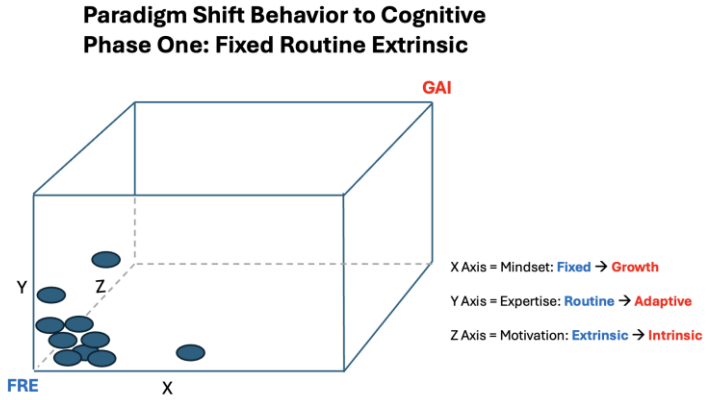

Figure 3: *E-Stream Teachers Paradigm Shift Design Block: Phase 1.*

In this pre-intervention view into their understanding, there is absolutely no evidence of any knowledge about the human brain or it's important connection to how children learn. Further, in every interaction where teachers describe children's behaviour the choice of verbiage appears to spring from a deep belief in stimulus-response thinking, repetitive rote prescriptions, and compliance to disciplinary methods—each of which stem from Skinnerian operant conditioning routines and reinforcement schedules that predict rewards or punishments. Figure 3 *E-Stream Teachers Paradigm Shift Design Block: Phase 1* quantifies the nine teachers as associated with the elements of three Axes of social construct for cognitive pedagogy as Fixed (F), Routine (R), Extrinsic (E). An example of how these educators understood their students is shown in the extract (Transcript: Recording#19) for the student (Child Zero) who has already been identified as experiencing significant turbulence in his RTE journey through school. Lead teacher introduces the student, Cee Zee.

In this example, we are given a clear visual of how teachers had come to understand the children who were in their care—basically, empty buckets to be filled rather than fires to be kindled.

01 Lead Teacher (LT): …he is very loving, very caring=
02 Interlocutor (IL): =What is his full name?
03 Child Zero (CZ): Cee Zee=
04 LT: = Cee Zee
05 IL: = Cee Zee (.) Bully =
06 LT: =He is, uh, loving and caring (.) =
07 IL: = uh huh =
08 LT: = uh, he is naughty, he is not… (*referring to an earlier discussion about this child*) as we discussed) (.) no? he is naughty (.) =
09 IL: = okay… fine (dismissive final) =
10 LT: =He's naughty…in naughtiness he will do…, ↓ you know… he gets over excited, ↑ ok Cee Zee?=
11 IL: =Got it.

Transcript: Recording #19 Bangalore 12/2023 – Cee Zee

In this short discourse excerpt, which sadly was judged sufficient to describe this child, we capture teacher mindset with regard to a general understanding of how the brain works and how children learn. It is clear from this description of child Cee Zee (all names are fictitious to protect the children), that the class teacher for fifth grade was trained in a Skinner-type S/R traditionalist routine. Such teachers typically focus on managing the classroom by managing child behavior, and seek compliance for rules and regulations, which is often conflated with discipline.

In the introduction of child Cee Zee, (Lines 01 – 05) it is clear that there has been an earlier discussion about his behavior with respect to aggression—this was the child who attempted to

choke another child in class—because the interlocutor immediately labeled him a bully—right in front of him. His happy smile vanished, replaced by a reactive frown. The lead teacher had set out by referring to him as 'loving and caring' (lines 01 and 06) but bolstered by the more astringent label from the interlocutor, proceeded to put him in his place. Mentioning the earlier discussion (as we discussed… no?)[3] she labels Cee Zee as naughty three times (lines 08 – 10) and is once more supported by her colleague, the interlocutor (Lines 09 and 11). To establish with certitude that this is a naughty boy, she explains in detail what it means (Lines 10) dismissing the gravity of the situation by offering a plausible solution in pseudo psychological terms as 'He gets over excited.'

It was clear from further discussions, video recordings, and field notes that this view was not a 'once off' because Cee Zee was a naughty boy—descriptions of all 23 participants were similarly dismissive of the children in a manner that was clear that the teachers were so overwhelmed with their undertaking that they either hadn't had time to, or didn't consider it necessary to get to know more than a rudimentary and cursory knowledge of the children. Figure 3 *E-Stream Teachers Paradigm Shift Design Block: Phase 1*, highlights that these teachers, who manage classrooms daily by managing children's behavior, demonstrate a clear misinterpretation of common constructs like *Mindset*, *Expertise*, and *Motivation*. When asked, they peremptorily claim, *"Yes I am Growth Mindset",* while it is undeniably clear that, by their actions and fixedness, they appear entirely opposite. Similarly, with *Expertise*, they invariably held the view that in order to become exppert, one only needed to *practice over time*. Sometimes they mentioned 10,000 hours as proof for this misguided[4] theory. They either never uncovered the fact that expertise can be detailed as *Routine* or *Adaptive [54]*, and given the choice would invariably choose the adaptive attribute. However, once again their actions in the classroom would instead align them closely with a *Routine* thinking cohort. When it comes to motivation, like most people these teachers were firmly of the opinion that *intrinsic* was better than *extrinsic* and claimed that they always practiced *intrinsic*. However, their actions again placed them in the exact opposite corner, daily dispensing with the 'tried and tested' tools associated with extrinsic motivation—rewards and punishments.

We contrast this onboarding baseline portraiture with results from *Phase Three*, particularly focusing on data that demonstrated a shift in teacher vocabulary and, in addition, corroborating evidence with statements from the children through a personalized instrument that highlighted the failure of their teachers to know details about their dreams, their skills, and their plan for life.

4.2. Phase Two

This phase consisted primarily of teacher professional development delivery. There was a perceived need to corral these nine teachers into a paradigm shift that was designed to elicit a vibrabntly different mental model about their approach to children and learning. Content was intentionally created and delivered in two formats—theoretical discussions regarding learning spaces that could be approached with a neural lens, and practical implementation of those theories that caused the teachers to experience them first-hand.

Theoretical exposition was derived from latest findings in the fields of learning sciences and cognitive neuroscience. The second borrowed from additional fields for implementation like applied psychology [71], occupational therapy [72], and kinetic and dynamic movement [35]. The following Figure 4: *Cognitive Flexibility Bilateral Coordination* highlights children who are demonstrating that (i) they want to learn, (ii) they can learn, and (iii) they have the innate ability to learn. This kind of thinking was not a conspicuous mental effort for the teachers, who shared a worldview that E-Stream children were less able, less willing, and frankly not smart enough.

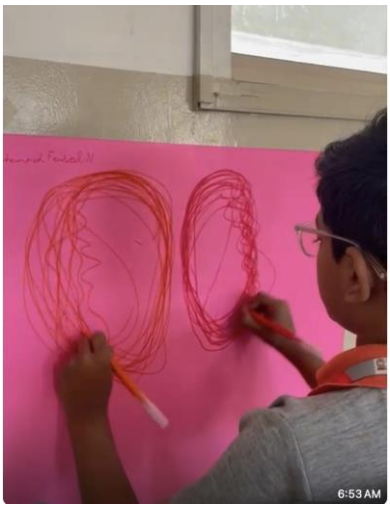

Figure 4: *Cognitive Flexibility Bilateral Coordination (Source: E-Stream 2024)*

This phase comprised a multi-pronged approach involving change for the teachers' mental models and for the children so that activities like bilateral coordination would help strengthen connections in the brain that support small motor skills, gross motor skills and focus. Other activities brought movement and intention together with bouncing balls, balance, goal directed objectives and cognitive and abstract mentalistic challenges.

[3] In Bangalore, saying 'NO' does not always imply negative, in this case NO is a question, as if she had said 'did we not?'

[4] The "10,000-hour rule" is a myth popularized by Malcolm Gladwell - a simplification of Anders Ericsson's research on deliberate practice.

Figure 5: *Cognitive Flexibility Exercise (Source E-Stream 2024)*

4.3. Phase Three

In Phase Three, we immediately notice that the entire learning environment has undergone a radical transformation. Instead of sitting in rows of desks reciting long formulaic rote routines, children (lead by teachers) are out of their desks, dancing, moving their hands and legs, clearly enjoying a nuanced learning cadence in embodied cognition routines. Teachers describe the difference in stark language, embracing the transformation because they can easily perceive the change in the children's engagement and attitude. Anomalies persist, however. Sometimes, a teacher will achieve desired results and still fail to make the connection with the curated activity that was prescribed to predict those wholesome outcomes. For instance, in the following excerpt, the teacher assigns a contrarian causal link to a good outcome as described here.

01 The first thing is, yesterday, whatever we have done, they were able to remember all the rules
02 and regulations – especially with the signature part.
03 I can show one worksheet, whatever the child has done here.
04 Here the same way… because we instructed… "whatever you are doing today…"
05 they have to remember. And they have to continue in the same way.
06 And that was surprising me.
07 And the second one is. Earlier the discipline was not up to the mark …
08 Today, also it is ok. With our instructions they were able to follow…
09 that was the thing that I was able to make out.
10 Third. We need help from you. We need music ma'am for those exercises…
11 whatever we are doing for that background music.
12 If we give children… they'll show more interest for that.
13 And they were instructing us only to go ahead with this music

Transcript: Recording #6 Bangalore 12/2023 – CogRs

As we make visible the implementation of the pedagogic model and the brain-based cognitive methods in action, the teacher is drowning in the deep end. This outcome was captured in a carefully scripted Cognitive Rehearsal instrument—LTP Making Visible [59] that is defined by three simple questions that predict deep understanding and encodes into long term memory [73,13]. The first question focused on giving teachers experience at avoiding an amygdala reaction by evoking a limbic surprise. (Question One: *What was surprising?)*

In Transcript Recording #6 we get a deep insight into the thinking of the English teacher as she makes sense of the intervention in a way that aligns with her prior understanding of how the human brain works and how children learn. As mentioned in Phase two, at the deep end of the cognitive pool the objective was to present opportunities to the learning brain through a carefully curated sequence of physical activations intended to exercise the visual-spatial juncture, the phonological loop, and frontal executive lobe. In these areas of the brain, children who experience cognitive flexibility strengthen white matter structures that help increase their working memory and enhance their capacity for learning with deep understanding.

In addition, exercises were designed to reframe the learning environment and elicit motivational energies away from extrinsic rewards and punishments sites of survival to an engaging opportunity for autonomy, mastery and purpose in an intrinsic setting. However, as shown in the excerpt above, as far as the teacher was concerned (question one: surprise, Lines 01 - 06), the reason the class was a success had more to do with the children's compliance in following her instructions—sign and date the worksheet—than any of the carefully sculpted neuronal activations that were executed with rigor. She failed to realize that when the children were in a learning space that privileged co-creation through application of intrinsic motivation, they typically are very pleased to take responsibility for their work and are proud to sign and date what they turn in.

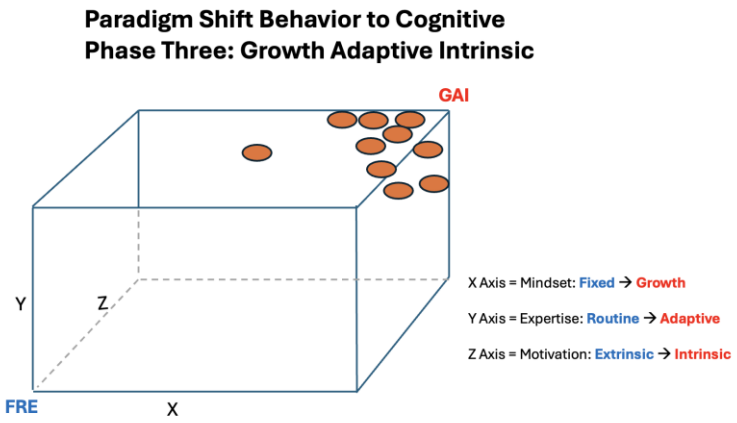

Figure 6: *E-Stream Teachers Paradigm Shift Design Block: Phase 3*

Similarly, with the second question (Question Two: *What did you already know but now see it in a new light?*), she failed to realize that the cognitive flexibility worksheet, which the children were so successfully and intelligently completing, was carefully curated to instantiate white matter structures in brain regions (e.g., the angular gyrus, the supramarginal gyrus, and the PFC) that with cognitive rehearsal increase the children's ability to acquire information, process it easily and feel good about solving intellectual problems with effort. Once more, she focused on their capacity to be compliant in following her instructions (Lines 07 – 09) as if compliance equated to learning. Finally, when asked what help she needed (Question Three: *What do you need help with?*), she again missed the point about embodied cognition, which increased children's engagement and processing power (Lines 10 – 13) by focusing on getting the right music for movement exercises, instead of stepping back and allowing the children appreciate their agency in music selection and attention. In other words, while the process was successful, the intention and curation were lost.

Nevertheless, as shown in Figure 6 *E-Stream Teachers Paradigm Shift Design Block: Phase 3*, over time and readily noticeable in their discussions by the middle and later weeks of Phase 3, the nine teachers were (i) aware of the possibility and (ii) at times were able to mentally locate themselves at the opposite end of the three-dimensional block visual from where they had set out a few months earlier. For instance, in Figure 7 *E-Stream Teachers Mental Model Shift Phase 3* Teach_1 was a clear leader of the pack—an early adopter, who became an influencer for her peer teachers who struggled somewhat at the deep end of the cognitive pool.

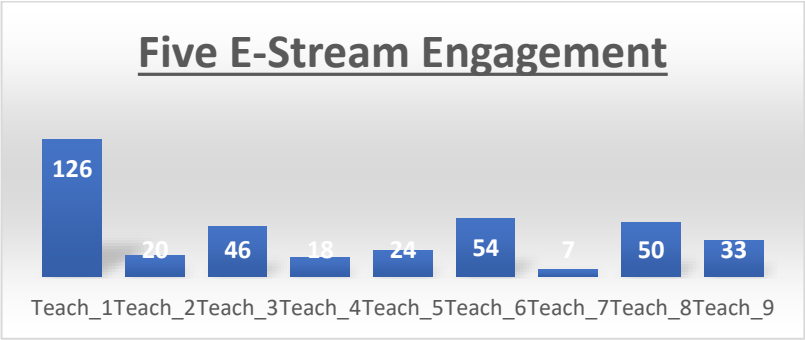

Figure 7: *E-Stream Teachers Mental Model Shift Phase 3 (Source: E-Stream 2024)*

Data were collected from LTP end-of-Zoom PD each week and follow-up opening of subsequent Zoom PD the succeeding week. In this excerpt, we get a window into how this early adaptor is 'making visible' her sense making process while using the new cognitive vocabulary. When she is asked to explain why she chose the phrase 'hyper resilient' as her LTP bookmark, she responded:

01 Teacher: I actually selected hyper resilient...., which was, you know, um,

02 what, what do I say? Uh, you...like .... with the dandelion, right?

03 Administrator: Correct.

04 T: So, why I felt was... they are more independent which I really like.

05 So that is why I chose that word. (Source: Dedoose Excerpt 2024 – Teacher 1)

Her choice of this phrase is meaningful because it forms a critical anchor theme in the professional development knowledge base. 'Hyper Resilient' as a cognitive construct is a portal to deep understanding with respect to an Autonomic Nervous System (ANS) Reactivity score that offers particular

insight into why some children struggle in school while others easily thrive (Boyce, 2018 [74]).

As discussed earlier, the teacher's use of a novel construct often makes clear that prior understandings, preconceptions and misconceptions are still evident in her thinking, even as late as Phase 3 of the school year. In this short excerpt, this early adopter teacher struggles with letting go of a treasured piece of inert knowledge that has been a mainstay of her academic toolbox for more than twenty years. Here she is wrestling with the idea that Mastery could be something more consequential in the context of motivation than her own notion of expertise as Sage on the Stage [75].

01 A: Why did you choose this word?
02 T: Because Mastery symbolizes your... uh…very good enough for your
03 uh… well-trained about any particular subject.
04 So, mastery of the subject, what they say…. That is why I chose it.

It begins with asking questions—regardless of whether they are meaningful or not. Making visible what the process for sense making is connects the disequilibrium so that myelination can do its work in the learning brain.

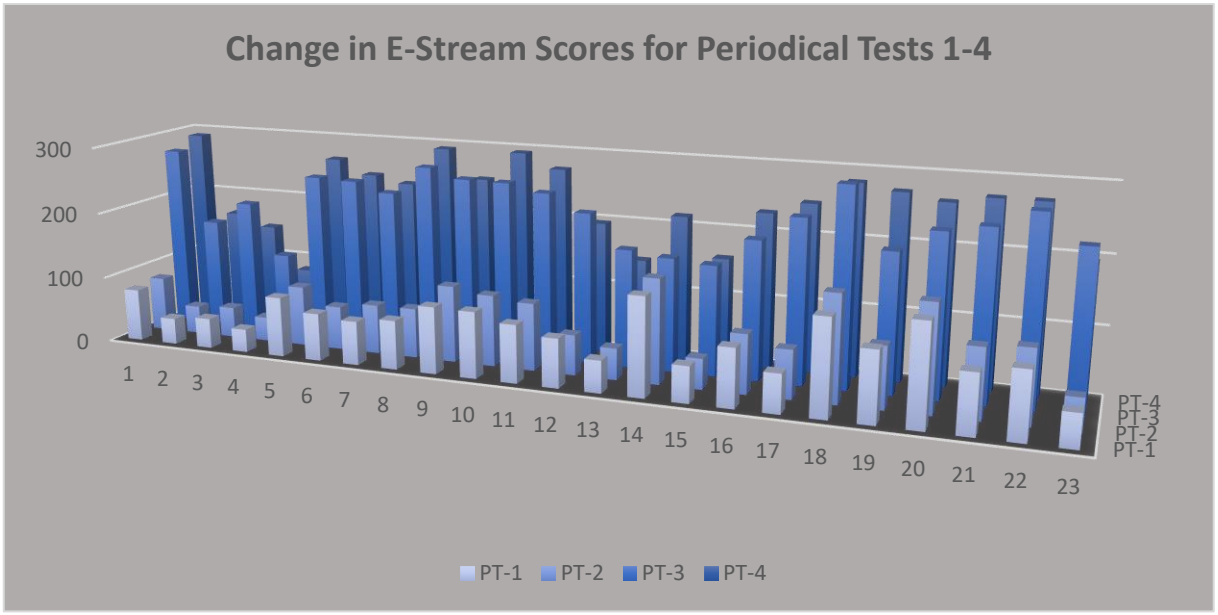

Figure 8: *Change in E-Stream Scores for Periodical Tests 1-4 (Source: E-Stream 2024)*

It turns out that some of the early adopters were willing to take risks, to step outside their comfort zones and to articulate in public a tolerance for ambiguity. These attributes are the hallmarks of adaptive expertise and a central theme in the shift from extrinsic to intrinsic motivation. The result was that all student scores improved, and the greatest improvement occurred after a moment of ignition delineated by teachers shift to implement cognitive flexibility routines and purposeful choosing of cognitive methods over older behaviorist habits. For instance, when teachers argued for 'enriched environments' and began to investigate the hidden meanings of 'neural plasticity' the children's academic scores leaped forward dramatically. As shown in Figure 8 *Change in E-Stream Scores for Periodical Tests 1–4*, the dramatic leap in student capacity for access, attainment, retention, and understanding is evident. In the next section, we describe a stochastic data analysis approach, which we used to model the probabilistic relationships between teacher feedback and subsequent student performance, acknowledging that factors outside the model also play a random, unpredictable role.

4.4. E-Stream Academic Achievement

The overriding question in this study pertained to change. Would a change in teachers mental models affect academic outcomes for their students? The null hypothesis is that there would be no difference in the PT1-4 test scores. We carried out a mixed method nested study with qualitative and quantitative data. A paired t-test was performed to compare end-of-year scores (PT-4) relating to all academic subjects against the intake results (PT-1). The value of t is 15.89. The value of p is < .00001. The result is significant at $p < .05$. Cohen's d = 3.31, a large effect.

Difference Scores Calculations

Mean: 148.47

$\mu = 0$

$S^2 = SS/df = 44153.61/(23-1) = 2006.98$

$S^2m = S^2/N = 2006.98/23 = 87.26$

$Sm = \sqrt{S^2/N} = \sqrt{87.26} = 9.34$

T-value Calculation

$t = (M - \mu)/Sm = (148.47 - 0)/9.34 = 15.89$

Table 2: *Periodical Test Scores for E-Stream Learners*

Sl No.	PT-1	PT-2	PT-3	PT-4
1	79	82	274	290
2	39.5	42.5	164	166
3	45.5	46.5	198	148
4	35	36.5	120	82
5	90	90.5	248	266
6	71.5	65.5	246	245
7	66	74	232	235
8	73.5	74.5	275	293
9	100	114.5	261	250
10	99	106.5	260	294
11	86.5	100.5	249	273
12	73	60	224	196
13	48	47	175	145
14	145.5	154.5	168	215.7
15	54	45.5	163	158
16	86.5	87.5	204.5	230
17	57.5	72	241	248
18	141.5	157	291	282
19	104	91	204	273
20	148.5	156.5	236.5	263
21	87.5	102.5	247	273
22	98.5	108	272	273
23	49	48.5	231	195

Dedoose E-Stream (Source: E-Stream 2024)

All students benefited from this intervention. Academic test scores ascertain that having begun the year in a very serious deficit (PT-1) and barely improved a smidge in the second periodical test (PT-2), all students responded with abrupt improvement as soon as the cognitive intervention kicked in (PT-3) and persisted through the end of the school year (PT-4). We calculated power (alpha=0.05): 1.0 which is also high. This high power suggests that the results of the t-test are very reliable.

5. Limitations

It should be noted, that although these results showed significant improvement in scores across all subjects, the small sample size raises some concerns regarding the robustness of these findings. The findings, while promising, highlight the need for further studies with larger sample sizes to establish more definitive and reliable results.

Though this study is limited by its small sample size, given the importance of the question and its widespread implications for middle and high school children, we recommend that it be viewed as a proof-of-concept study that illuminates possibilities highlighted by investigating learning spaces via a neural lens. It was only a short lifetime ago that this arena for study was treated as a bridge too far [76]. There is strong evidence that the decade of the brain contributed to public awareness in relation to possibilities that affect society as a result of an outpouring of new and emergent knowledge [77]. In areas of mental health, education and suicidality there is a growing realization that solutions are being found in new scientific approaches to education [78,79], social and emotional learning [80], and mental wellness [81,82].

It is feasible that the study sample in a large school in Bangalore accurately mirrors populations in similar cities across India. There are, however, questions pertaining to culture and geography that prohibit generalizability to schools in say, southern California or northern Sweden. There is a cognitive question that might be more meaningful for future studies. Are these potential confounding factors persistent or are they only confounding in a traditional model that seeks to manage behavior through Skinnerian approaches rather than focusing on methods that are designed to architect a learning brain? Neural diversity in a school population in Bangalore probably mirrors neural diversity in school populations anywhere. When viewed through a neural lens teachers focus on white matter structures that underpin cognition and deep understanding. In other words, brain is brain—whether in Bangalore or Sweden. These are questions that more research might seek to answer.

6. Conclusions

By any measure, this study was an unusual one. The small N (9 educators, 23 students), though problematic, was however, real. It represented typical classroom challenges and practices in schools across India. This study described a cohort of children who were 'streamed' participants in an innovative brain-based intervention that sought to eliminate opportunity and/or achievement gaps for 5th graders. The intervention, originating 11.5 hours away, was delivered via zoom to educators who were willing to take a risk and step outside their comfort zones—to implement new methods in cognitive brain-based design.

The question was, "How would 'making visible' affect the mental models of incumbent teachers when they are dropped into the deep end of the cognitive pool and asked to embrace a novel methodology and practice? Findings highlight teacher intentionality in architecting children's brains through use of a brain-based pedagogic model was successful at impacting learning outcomes and related life skills?

From a paradigm-shifting perspective (cognitivism over behaviorism), teachers were invited to reframe their mindsets regarding solutions for disruptive behaviors. They adapted traditional extrinsic rewards/punishments instincts [83], to an intrinsic approach established on a nuanced definition that privileged autonomy, and mastery and lead to purpose [81,55]. Neuroscience [84] points out that behavior is simply communication—that all behavior has a neural substrate and that teachers can look for neural substrates to solve unexpected behavior.

Educators were trained to think in terms of neurotransmitters instead of grades; dopamine instead of behavior [85]. They were asked to abandon public-shaming practices that included isolation, sarcasm, threatening changes in body language—modalities that tend to pinpoint children's behavior in either a positive or negative way in a competitive public space [86].

Finally, and probably most providentially, they were introduced to new information that is widely available since the 'decade of the brain' [87], and includes salient understandings about how genetics and epigenetics impacts the learning brain [15].

Findings were also unusual. Teachers who began the trial with little enthusiasm and distrust of a new method, ended the year with accolades from fellow teachers, happy parents, and very successful students. All children improved significantly. With no need for rewards or punishments teachers saw how children engaged easily when choice was co-created, solved difficult problems when mastery was co-created, connected effort to mastery and mastery to purpose. Beyond progress in literacy, they were very pleased to understand that in achieving these skills, she was merely connecting students' innate capacity for syntax, grammar, and vocalization with white matter structures that also facilitated regional languages (Kannada, Hindi, and Sanskrit), and transferred easily to other academic subjects including Science, Mathematics, Computer skills, and Environmental Science.

Tantalizing questions about this emerging field of brain-based teaching and learning remain for future research. Educators are interested in further explorations into understanding the impact of intentionality about intrinsic motivation over traditional extrinsic models.

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