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Published in:
Teacher Education Advancement Network Journal

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
White, W., & Malkus, A. (2019). Teacher Emotions Matter: Bridging Teacher Learning and Mathematics Instruction in the early years Using an Affective Instruction Design. *Teacher Education Advancement Network Journal*, *11*(4), 21-34.

Teacher Emotions Matter: Bridging Teacher Learning and Mathematics Instruction in the early years Using an Affective Instruction Design

Teacher Education Advancement Network Journal

Vol 11(4) pages 21-34

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Abstract
Interest in the role of emotion within mathematics education has increased in recent decades. Within a case-study framework, I explored how an Affective Instructional Design (AID) supported an early years teacher develop the capacity to change her instructional approaches, influenced her mathematic affect, and the affective experiences of her students. My conceptualisation for AID is based on an integrated framework approach drawing from emotion-learning theory, instructional design theory, and teaching and learning mathematics theory to integrate affect and cognition throughout the instructional process. Participants included 15 kindergarten children and their class teacher from a K-12 school in Tennessee, USA. Measures included teacher interviews, video recordings of 13 mathematics lessons, and field notes. Findings from this small study suggest instructional supports such as AID influence teacher capacity to bridge new learning and enacted practice; preliminary findings indicate AID contributed to a rise in positive teacher and learner affect, and improved teacher capacity to plan and implement quality mathematics learning environments.

Keywords
Mathematics; Teacher; Affect; Learning; Attitudes; Affective Instructional Design.

Introduction
Teacher emotions matter. This idea has garnered increasing attention in emotion-education research in recent decades, contributing in part to what Pekrun and Schutz (2007) suggest is a fragmented conceptualisation of emotions in education. In response, a number of researchers call for clarity through focused study on the affect-cognition interface (Fiedler and Beier, 2014; Neville, 2013; Pekrun *et al.* 2007). This interface acts during any experience and involves the bi-directional interaction of emotions and cognitive processes, leading to enacted behaviours (engagement vs avoidance) that influence learning and attitude formation (Pekrun *et al.* 2002, 2007). The affect-cognition interface offers scope to better understand the relationship between teacher emotion, teacher learning, and enacted instruction, which as Chen (2019) indicates is an area of research needing a greater depth of investigation. It is through this lens that I embarked on the present research with the aim of better understanding the relationship between teacher emotion, teacher learning, and enacted instruction.

This paper presents the processes and findings related to my exploration of how an Affective Instructional Design (AID) supports teacher emotion and learning, enabling new instructional approaches for teaching mathematics in the early years. The paper begins by defining key terms in emotion research and outlining the relevance of emotion research within mathematic education. This is followed by a review of literature exploring the role of emotion in teaching and learning, and the processes undertaken to develop an affective instruction design (AID).

Citation
White, W. & Malkus, A. (2019) ‘Teacher emotions matter: bridging teacher learning and mathematics instruction in the early years using an affective instruction design’, *TEAN journal,* 11(4), pp. 21-34.

Key terms in Emotion Research

Affect and emotion are used synonymously in the literature. An individual's emotion, or affect, is influenced by their affective experience, a subjective evaluation of environmental and social stimuli, (pleasant/unpleasant) that trigger affective states (happy, frustrated, calm, nervous). Affective states vary in intensity, ranging from positive to negative, and can be recognised by bodily-physiological changes (increased heart rate, blushing cheeks), and expressive feelings (smiling, crying) (Linnenbrink, 2007). Habituated affective states become more stable, interacting with cognitive processes to influence attitude formation (Hannula *et al.* 2016). Attitudes are recognised as an individual's automated responses (expressed feelings/enacted behaviours) for liking or disliking (Zan *et al.* 2007). Within this study affect, emotions, and affective states (positive or negative) will be used interchangeably, and attitude will be used to capture an individual' affective state.

Emotion in Mathematics Education

Applied within Mathematics Education, the affect-cognition interface offers insight into factors that have given rise in Western societies to a culture of negative mathematical attitudes. Research suggests school learning experiences contribute to negative affect through traditional instruction, such as isolated working, memorisation, and rote rehearsal (Walls, 2007; Zan *et al.* 2007). As children progress through school, they express increasingly negative attitudes for mathematics (Grootenboer and Marshman, 2016) and upon leaving school these attitudes cycle into an existing culture of negativity toward the subject. For the individual who becomes a teacher, their role in this cycle has significant implications. The teacher provides the environmental and social stimuli to promote affective experiences for learners and the instructional choices the teacher makes are influenced by the teacher's own mathematic affect (Frenzel *et al*. 2009). Teachers with negative mathematic affect rely heavily on traditional instruction, perpetuating the negative cycle. It is the idea that the teacher's mathematic affect has implications within the wider cycle of negative affect that led me to explore how an Affective Instructional Design (AID) could support one early years teacher overcome her own negative mathematic affect to adopt improved instructional approaches in her practice.

A Review of Literature

In order to disrupt the cycle of negative affect it is important to identify how and when it begins. Fielder and Beier (2014) indicate educational settings are a primary source of children's affective experiences. With this in mind, my literature review begins by exploring early years mathematics literature for a source of negative learner affect and the teacher's role in it.

Mathematics teaching in the early ears and the Cycle of Negative Affect

Early years literature suggests children have a natural affinity for mathematics, inquiring, reasoning, and problem-solving informally through play and in everyday experiences (Clements and Samara, 2014). This raises questions about when and how negative affect begins. As children move through pre-school, entering Kindergarten at age 5, their experiences with learning mathematics transitions from informal to formal engagement. Emphasis in teaching and learning turns to developing numeral knowledge (Purpura *et al*. 2013), requiring early years' teachers to adopt curriculum-based teaching to formally engage learners with mathematic concepts, methods, and language (Clements and Samara, 2014). At this point it becomes possible to identify a source of negative affect for both the teacher and the learner. Many early years teachers find the transition to systematic, formal mathematics teaching challenging and in juxtaposition to their early years' philosophy which places value on informal, play-based instruction (Ginsburg and Amit, 2008). When this happens, the teacher's pedagogical beliefs are challenged, presenting the potential for a rise of negative affect through their instructional goal appraisals (Schutz, 2014). Such feelings impact teacher motivation and capacity to engage students in meaningful curricular experiences (Campbell, 2012), which is significant based on Frenzel *et al.* (2009) who suggest a direct correlation between teacher and student emotions. The teacher who feels de-motivated about the instructional approaches, may pass this feeling of negativity on to students. Additionally, some early years teachers feel they lack the knowledge and understanding needed to bridge informal and formal mathematics (Ginsburg and Amit, 2008). In these situations, they adopt instructional approaches characteristic of traditional elementary grades including rote rehearsal and isolated working (Clements and Samara, 2014). For young learners this signals a potential source of negative affect as the play-based environments that give rise to positive affect such as curiosity or joy (Elkind, 2008) are replaced by mechanical and procedural practices void of play or natural mathematical curiosity. Stigler and Hiebert (2009) suggest current approaches to professional learning that might address this issue are ineffective and a gap exists between teacher learning and enacted practice. They call for in-class support systems to address this issue. From this perspective, teacher affect in the early years necessitates exploration for the sake of supporting teachers to bridge professional learning and enacted practice. In this study, I introduce an Affective Instructional Design (AID), underpinned by the affect-cognition interface and the control-value theory of emotion (Op't Enyde *et al.* 2006; Pekrun 2007). AID addresses teacher affect as a way of bridging the gap between teacher learning and enacted practice. These ideas are explored in more depth in the next section, which provides a review a literature that informs the conceptualisation.

Emotion and Learning

Whilst research on emotion enjoys a rich history, emotion-education research investigating the role of the affect-cognition interface according to student and teacher experiences has received less attention. Becker *et al.* (2014) address this issue through crossover theory, suggesting emotions can be elicited through interactions with others. They found teacher emotions and instructional behaviours are significant situational factors that influence student emotions and propose emotion contagion, an unconscious automatic response that occurs in human interactions, connecting teacher and student emotion. Burgess *et al.* (2018) echo the teacher-learner relationship through their focus on social contagion, suggesting social connectedness leads to "the involuntary 'catching' of behaviours and attitudes" (p. 1) that inform learner interest and engagement in both the short and long term. Other researchers have investigated the affect-cognition interface through cognitive appraisal theory. Frenzel *et al.* (2009) suggest cognitive appraisals influence teacher-learner emotions. The authors posit that during instruction teacher-learner appraisals interact bi-directionally, influencing affective experiences and informing instructional choices. Pekrun *et al.* (2007) identify cognitive appraisals as a mediating force between academic emotions and environmental factors including quality of instruction, learner engagement, classroom cohesion, and self-belief. They present the control-value theory of achievement emotions, proposing that when an individual feels in control of achieving an outcome and values the learning, they are likely to make positive appraisals leading to positive academic emotions. The authors extrapolate their theory to the classroom teacher, suggesting that when a teacher feels a sense of control and value for the planned and enacted instruction, there is potential to trigger positive affect. Building on the control-value theory, Buff *et al.* (2011) examine ways of activating positive affect during instruction. They identify four instructional features: outcome focus; activity focus; social influence; and meta-emotions, as having potential to promote a high sense of control and subjective value for the teacher and the learner. These features of instruction guided the next part of my literature review, exploring mathematics instruction in the early years, leading to an overview of AID.

Mathematics Instruction in the early years and Teacher-Learner Affect

A number of researchers recognise the role of emotion in teaching and learning mathematics. Hargreaves (2005) suggests planning is an emotionally rich activity that supports teachers' establish a meaningful connection to the instructional process. Such connection is most effective when planning is clearly presented and outcome focused, defined by an overarching goal, essential content knowledge, key vocabulary, conceptual understanding, and component activities that guide the lesson (Hattie, 2012; Peña-López, 2009). Through planning arises the opportunity to establish a high sense of control and subjective value for the instruction, supporting positive teacher affect.

Dunphy *et al*. (2014) emphasis the teacher's strategic choice of instructional approaches as essential to engaging children cognitively and emotionally with learning to support their developing mathematical proficiency in the early years. Explicit Instruction (EI) is one such instructional approach (Clements and Samara, 2011). EI is characterised by quality teacher-child interactions and purposeful use of concrete experiences, symbols, language, and pictures that when strategically organised, create a learning trajectory to cognitively and emotionally support children transition from informal to formal mathematics. A significant factor influencing the progression along the trajectory is the teacher role, which becomes multi-faceted. The teacher actively engages learners as a provider, demonstrator, learner, observer, coach, and mediator (Edwards and Malicky, 1996) using discussion, questioning, feedback, and modelling to support children gaining ownership over their learning (Solomon and Black, 2008). Ownership is indicative of high control-value, suggesting EI approaches will support a rise in positive affect.

Through EI approaches, play and problem-based activities can be used strategically to support affective and cognitive engagement with mathematics in the early years (Dunphy *et al*. 2014). Through play children informally explore mathematical ideas, develop a sense of curiosity, and connect prior learning with new thinking (Burton, 2010). Problem solving supports creative, formal mathematical thinking, leading to mathematic proficiency and high task value (Burton, 2010). Problem-solving can also be a source of heightened affect which can be debilitating to learning because of a decrease in capacity for cognitive investment (Zan *et al.* 2007). To regulate heightened affect, the role of teacher as mediator is significant, providing the teacher the opportunity to teach children reappraisal skills and to support them thinking more positively about negative affect (Attard, 2014). What once was appraised as a threat leading to avoidance is reappraised as a challenge, triggering engagement behaviours (Jamieson *et al.* 2018). Significant in this process is the teacher's use of reflection. Through reflection the teacher can assess children's cognitive and emotional experiences, which Strack *et al.* (2017) highlight as essential for supporting reappraisal processes. Björklund (2012) suggests reflection allows young children to appraise what they know, what they need to learn next, and how to bridge the gap. For a teacher, critical reflection supports self-examination, exploring the relationships between past and present experiences making possible new thinking, leading to new practice (Bolton and Denderfeld, 2018). Collectively these ideas suggest the strategic use of play and problem-based activities, paired with reflective practices may support an improved sense of control and value for the teacher and learners' emotional experiences during the instructional process.

An Overview of the Affective Instructional Design (AID)

Effective instruction begins by establishing clear learning objectives that are followed by systematically structured instructional events that include all aspects of instruction and actions by teacher and learners that have a direct effect on the learning (Gagne et al. 2005; Rosenshine, 2012). Informed by the review of literature, AID's 3-phase planning framework has been designed to support positive teacher-learner affect through attention to outcome focus, instructional events, and meta-emotions. Each phase is defined in the following way, with three assumptions informing how AID will support positive teacher affect:

- The Pre-Planning Phase adopts an outcome focus, requiring the teacher to identify the overarching goal, essential content knowledge, conceptual understanding, and key vocabulary for the lesson. The assumption is, this planning will support the teacher gain directional control and subjective value for the instruction, leading to positive affect.

- The Instructional Planning Phase has a structured planning trajectory involving four segments, each drawing from EI approaches. Segment 1 adopts an outcome focus using teacher-led instructional strategies to orient learners to the learning objective and to support stimulating learner curiosity. Segments 2 and 3 adopt an activity focus that supports a transition from informal play-based activities to formal problem-based activities. These segments are characterised by small group interactions, supporting high task focus and quality peer-teacher interaction. Segment 4 is defined by collaborative reflection to support developing appraisal and reappraisal skills. Underpinning each segment is a focus on multi-faceted teacher roles to support learner affect and cognition. The assumption is the planned instructional events and purposeful use of teacher role will promote positive learner affect, which will trigger a rise in positive teacher affect.

- The Post-Instruction Appraisal Phase is completed after the lesson, requiring the teacher to critically reflect on a series of questions exploring emotions, thoughts, and actions during instruction. The assumption is the systematic use of reflection will make possible new thinking and feeling, leading to a high sense of control and value for the instructional process and a rise in positive affect.

This study explored how AID supported an early years teacher overcome her own negative mathematic affect to adopt improved instructional approaches in her practice. The research was guided by the following questions:

- How does AID affect teacher capacity to adopt new instructional practices?
- How does AID affect children’s attitudes during mathematics learning?
- How does AID affect the teacher’s affect experiences teaching mathematics?

Method

A mixed-methods, exploratory sequential design was used, allowing for an in-depth examination of AID’s influence on teacher capacity to adopt new instructional practices, her affect experiences and the affect experiences of her learners. Through merging qualitative and quantitative data, a comprehensive analysis of the research question was possible, enhancing the integrity of the findings (Creswell, 2014). Data sources included 13 mathematics lesson video-observations capturing evidence of attitude, semi-structured teacher interviews, and field notes. Video-observation data underwent descriptive analyse using SPSS and qualitative data was analysed thematically, applying Braun and Clarks’s six-step approach examining and extracting common themes within the data (Braun and Clarke, 2006).

The participants included a veteran kindergarten teacher and her fifteen students, ages 5 and 6 (mean = 5 years, 8 months), enrolled in a kindergarten program of a university K-12 school in East Tennessee. Ethical approval was obtained from the East Tennessee State University Institutional Review Board. An information session was held for the early years department at the local school where the kindergarten teacher volunteered her participation in the study. Participation in the study was based on administrative, teacher, parental, and child informed consent, and the identity of participants was kept confidential using pseudonyms.

Instruments and Data Collection

Three phases of data collection occurred with teacher training on the use of the AID intervention taking place between the first and second phase.

Phase 1: Pre-intervention data included a semi-structured teacher interview, field notes, and three 1-hour video recorded mathematics lesson observations capturing evidence of learner attitude. This data were analysed to establish a baseline of evidence for understanding existing teacher instructional approaches and teacher-learner affect for mathematics. Following this phase, and in the week prior to the second phase of data collection, the teacher participated in a series of four one-hour professional development sessions specifically designed to support her learning to use AID for planning kindergarten mathematics. Table 1 provides an overview of each session.

Table 1. Overview of Teacher Training on the Use of AID.

Teacher Training Sessions	
1	Introduce the *AID* Planning Framework • Phase 1 of AID: Introduce ‘Outcome focus’ • Define content knowledge, conceptual understanding, key vocabulary – link to CC Kindergarten Standards • Stimulating curiosity through instruction

2	Introduce Phase 2 of AID
	• Define the teaching and learning trajectory
	• Identify principles of explicit instruction applied to outcome focus; activity focus
	  o Effective use of learning intentions and success criteria
	  o Play using props, puzzles, stories, and role
	  o Effective use of technology

3	Explore Phase 2 of AID
	• Identify principles of explicit instruction applied to social influence; and meta-emotions
	• Develop strategies to promote positive affect states in early years (Kindergarten) mathematics
	  o Teacher talk: feedback, questioning, promoting growth mind-set
	  o Small group organisation
	  o Problem-based approaches
	  o Recognising and responding to heightened affect

4	Exploring Phase 3 • Understanding and applying reflective questions to promote personal professional development • Practice Plan: use AID to plan a mock lesson

Phase 2: Intervention phase data was collected during a two-week period, capturing ten 1 hour video observations of structured math lessons using AID, and included field notes which provided contextual information to support video data analysis. Video and interview data were transcribed and notes were added to capture inflections, tone of voice, volume of speaker, facial expressions (Cohen *et al.* 2018). A Mathematics Attitude Checklist (MAC) and time-sampling were used to code video data for markers of attitude during each lesson segment. Attitude was determined to be an accurate measure of affect based on Zan *et al.* (2007) who define it as the expressed feelings and enacted behaviours reflecting an individual’s affective state and Hannula et al. (2016) who define attitude as “an interpretive instrument to understand the reasons for intentional actions” involving complex affective and cognitive interactions (p. 10). Markers of attitude adopted in MAC were drawn from Chapman (2003) who defined them in terms

of engagement, resourcefulness, and resiliency. Learner engagement includes any on-task behaviour including: active listening, use of mathematical language, and purposeful participation (Wells and Claxton, 2008). Resourcefulness is recognised as personal and social goal oriented actions including seeking support, accessing resources, and acting on ideas from others (Zauszniewski *et al*. 2010). Resiliency is a construct that allows learners to overcome negative affective states and is evidenced by task-persistence, willingness to try new strategies, working through heightened affect, and responding positively to peer or adult suggestions (Lee and Johnston-Wilder, 2017). The MAC instrument was used to capture evidence of five markers of learner attitude: active listening; attentiveness to the task; task persistence; purposeful social interaction; positive responses to peer or adult suggestion.

Phase 3: Post-intervention data collection followed one week after the intervention and included a semi-structured teacher interview allowing for a comparison of pre and post changes to attitude.

Addressing Design Threats

Within the design purposeful steps were taken to minimise construct threats and to support validity. A secondary coder, independent of the research project was recruited to address measurement bias inherent to MAC. The MAC checklist was piloted and satisfied an internal consistency test (Cronbach's α=0.875). To ensure continued trustworthiness of data collection, recognising the potential for researcher sensitisation, the secondary coder rated a random blind selection of 30% of the baseline video data and 30% of the intervention video data. The results of the inter-rater analysis were 0.906.

Findings and Discussion

Analysis of video, transcript, interview, and field note data across the three phases of data collection provide evidence of how AID influenced changes to instruction and teacher-learner affect.

Pre-Intervention Data

Negative teacher affect

From theme 1, which explored the teacher's mathematic affect prior to the intervention, a negative sense of control related to both subject mastery and subjective value for the instructional practices emerged indicating the teacher had negative mathematic affect. Aligning with Ginsburg *et al.* (2008) the teacher expressed a lack of understanding for how to teach mathematics in a meaningful way that would ensure children could pass their assessments. She felt worksheets were the only strategy to '*make sure they can pass the tests'*. When asked how she felt teaching mathematics, the teacher expressed feeling '*anxious*' and that teaching math was '*not fun*'. Combined, the teacher's focus on achievement goals and her instructional anxiety negatively influenced her sense of agency, leading to reliance on instructional approaches for which she held low subjective value. The teacher's low subjective value was further evidenced as she described her perception of the children's learning experience, '*the concepts are too difficult*' and '*they don't mean anything to the children*'. These findings align with previous research (Hiebert and Grouws, 2007; Schutz 2014) suggesting when conflict exists between a teacher's philosophical beliefs and enacted practice there is potential for a rise in negative affect. These feelings led the teacher to adopt what Stipek *et al.* (2001) describe as characteristics of traditional American elementary math classes: a procedure is introduced, children rehearse step-by-step instructions, and then engage in independent practice. Findings from the video data provide corroboration indicating the teacher followed a similar three-part structure beginning the lesson with the teacher introducing and modelling the task, followed by children rehearsing procedural steps, and finishing with independent task completion.

Intervention Data

A rise in positive affect experiences

Video data, capturing indicators of attitude were collected for the 10 intervention mathematics lessons and analysed at the group level (N=1). Figure 1 summarises the findings, suggesting throughout the intervention, participants demonstrated a rise in positive affect experiences.

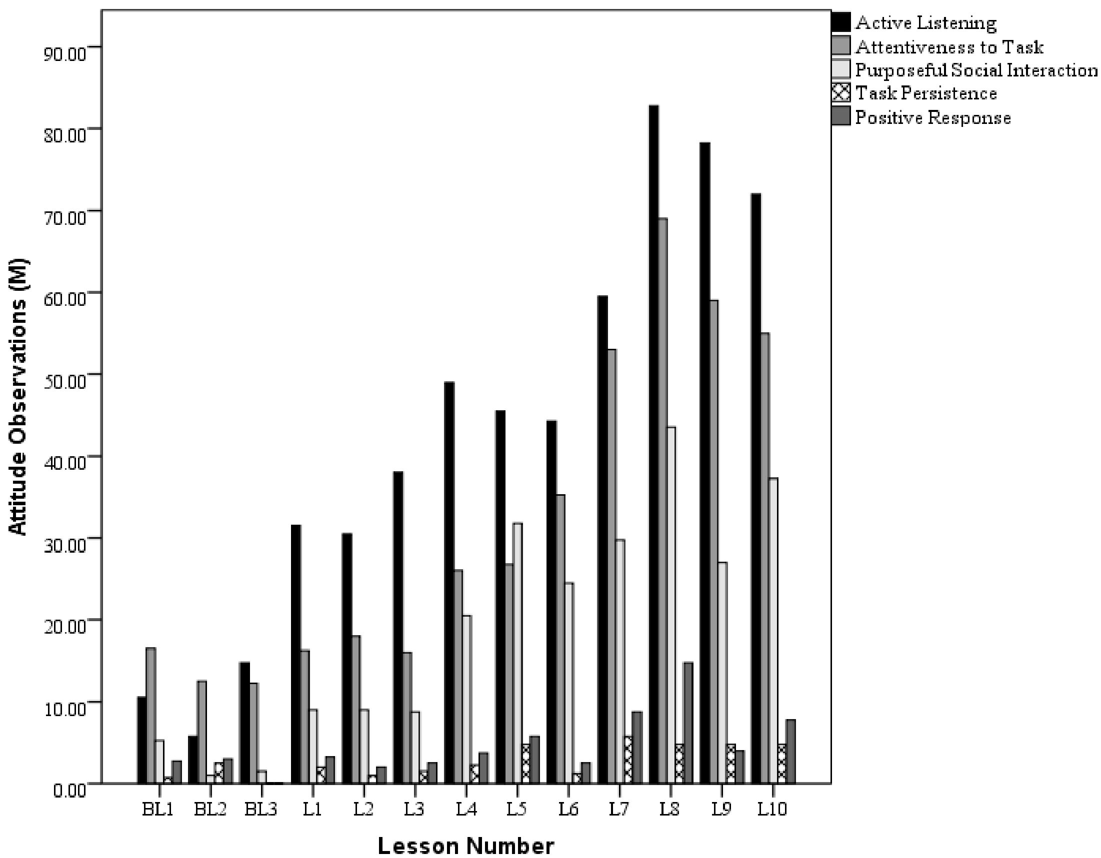

Figure 1. Observations of Five Measures of Attitude across 13 Math Lessons. *Note.* BL=baseline lesson during which no intervention was occurring; L= a lesson using the AID intervention.

The change in markers of attitude during the intervention, in particular active listening, attentiveness to task, and purposeful social interactions, could be attributed to the new instructional approaches adopted using AID. Where pre-intervention lessons involved a large segment of isolated and independent working, AID lessons were defined by social interaction characterised by small group-high task focus facilitated using multifaceted teacher roles. Early Year's experts acknowledge small group organisation and high-task focus supports making learning more visible, allowing the teacher to discuss and question mathematical understanding to gauge development along the learning trajectory (Clements and Samara, 2011; Dunphy *et al.* 2014).

Further video-transcript and field note analysis (Braun and Clarke, 2006) provide clarity about the impact of AID on instruction and teacher-learner affect.

Changes in teacher talk

The second theme revealed improvements to the teacher's use of teacher talk. The teacher increased her use of mathematic vocabulary, questioning, and celebratory expressions acknowledging effort and achievement. During intervention lessons the teacher could be heard using key phrases, '*That's wonderful. Tell me how you found that out.*' or '*How could we decide what comes next?*' Researchers indicate teacher talk is essential to children's emotional and cognitive development. Doabler *et al.* (2013) acknowledges the importance of teacher talk for modelling mathematics to support at-risk early year's learners, while Mercer and Hodgkinson (2008) define exploratory talk as a way of connecting language and thought, leading to deeper understanding.

Social Influence

A third theme highlighted social influence as a factor leading to meaningful engagement with mathematic concepts. Burgess *et al.* (2018) define social influence in terms of social contagion, a process through which one individual influences the attitudes and engagement of another. Video-data analysis evidenced how improved teacher-child mathematical interactions sparked children's eagerness to spontaneously share mathematical experiences. Prior to the start of one lesson a child excitedly sought the teacher's attention, smiling and tugging at her arm. When she turned to him he engaged in the following revelation:

> Miss…Miss… I want to tell you something. Laassst niiight my sister…[pausing, creating anticipation, the bold font highlights the child's emphasis on key words]… **SAT BESIDE ME** for dinner! That's one of our words!! [Big smile] And… and… I put my dinner **INSIDE** me… and that's one of our words, too!
>
> (teacher and child laughing).

That excitement encouraged two nearby children to spontaneously join in. The first child exclaimed and demonstrated, *'Oh, oh, and I put my food **IN** my mouth, too!'* and the second child shared, *'I put my hands **ON** my head'*. All participants enjoyed smiles and laughter during the exchange, demonstrating positive affect states as they engaged with mathematical sharing. Although these events could be characteristic of children in any class at this age, when compared to the baseline analysis which indicated mathematical discussion and purposeful social interactions were limited, this change in tone, emotional expression and excitement about meaningful real-life mathematics was striking and unique to the setting. It made learning visible, revealing the meaningful connections children were making between real world experiences and mathematics learning. Clements and Samara (2014) suggest this sort of social exchange, allowing children to discover connections between mathematical concepts and their real world are essential to developing positive mathematical dispositions.

Play and Problem-based instruction support positive affect experiences

During lessons the teacher used play and problem-based scenarios to explore number concepts. A fourth theme indicates these instructional approaches contributed to positive affect experiences and developing mathematical thinking. In one lesson the children entered the classroom to discover their class calendar had been mysteriously knocked over, leaving materials scattered on the floor. The scenario stimulated children's curiosity and interest in the topic, supporting their engagement in problem-solving. This outcome echoes findings from Elkind (2008) who identified play as important to supporting children engage with deep thinking. Through play, the teacher adopted open questioning to promote formal engagement with mathematic concepts and language; *"What do you see? How will we put the calendar back together? What information do we need on our calendar?"* This approach supported children adopt formal mathematic language:

Child 7: '25 has to go after' [pointing to 22, 23, 24]
Child 2: 'Sunday is first'

According to Hiebert and Grouws (2007) play and problem-solving lead to meaningful learning opportunities that support children overcome confusion to establish strong mathematical connections and positive learner attitudes.

Post-Intervention Data

Positive teacher affect through positive appraisals

Findings from the post-interview teacher survey suggest a fifth theme revealing teacher appraisals positively influenced teacher affect. Echoing previous research (Frenzel *et al.* 2009; Pekrun *et al.* 2007) the teacher made positive goal appraisals related to learner behaviours, classroom cohesion, and quality of instruction resulting in the teacher's improved self-belief. When asked to describe changes in learner behaviours and classroom cohesion the teacher highlighted emotive changes *'the classroom environment has become electric'* and the children have become *'eager to discuss mathematics'*. They are '*excited by the connections they make*' between mathematics and their own daily experiences and *'they display an increased interest and ability to share and help each other with activities'*. The teacher appraised aspects of quality of instruction positively explaining, '*we cover so much more content*' and '*I can see how my consistent use of the vocabulary in the lessons really made a difference in the kid's use of vocabulary*.' Adding to this, the teacher expressed feeling 'exhilarated' through the process and that AID supported her to *'understand lesson design'* and to '*really see who "gets it" and who is still struggling'*. The teacher's positive appraisals about content coverage, capacity to gauge learning, and lesson design, indicate improved feelings of control and value for the instructional process, signalling a positive change in her mathematic affect.

Limitations

While initial findings exploring the use of AID are promising, generalisation is inappropriate due to the small scale of the study. It may be the novelty of the instructional changes influenced affective experiences without any lasting impact on individual affect. A key limitation in this study was the absence of a longer term follow-up exploring any lasting impact of AID on teacher practice. A long-term study, including randomised-control, multiple teacher, and multiple class trials involving more complex analysis and improved design would account for habituation, and provide opportunity to examine the processes that influence teacher change leading to a better understanding of how AID supported the teacher and any lasting impact on teacher practice. A more robust cycle of research is required before the findings are considered more than preliminary.

Conclusion

A teacher's affect orientation plays a significant part in the cycle of mathematic affect. It influences the teacher's capacity to bridge new learning with enacted practice, which in turn informs the environmental and social stimuli that directly influence children's affect (Frenzel *et al.* 2009). In this study, I explored how AID supported one teacher overcome her own negative affect to adopt new instructional approaches in her practice.

Informed by Buff *et al.* (2011), AID's three phase planning framework provided the teacher a clear instructional trajectory attending to outcome focus, activity focus, social interactions, and meta-emotions. Based on emotion research, the assumption was made that AID would support the teacher to develop feelings of control and subjective value giving rise to positive affect (Pekrun *et al*. 2002, 2007, 2014). Findings confirm AID was a catalyst for positive affect, supporting the teacher to bridge professional learning and enacted practice through positive appraisals that led to her increased sense of control and subject-value for the instructional process. Using AID, the teacher was able to adopt new instructional approaches that led to increased positive affect experiences for learners. Findings suggest AID positively influenced the teacher's affective states during planning, delivery, and following instruction, leading to an increase in positive affect for teaching mathematics. This study provides further clarity on the close relationship between teacher-learner appraisals, emotion, and instruction (Frenzel *et al.* 2009) and the bi-directional relationship between affective experiences, learning, and affect (Op't Eynde *et al.* 2006; Fiedler and Beier 2014). The teacher's positive goal appraisals influenced her capacity to enact new instructional approaches. New instructional approaches provided positive affective experiences for learners, leading to positive teacher appraisals, and triggering a cycle of positive affect and engagement with learning. This finding offers valuable insight into the potential AID presents for disrupting the cycle of negative affect for mathematics.

AID addresses previous research (Stigler and Hiebert, 2009) calling for an in-class system of support to aide teachers' bridge new learning with enacted practice. Most interesting in my study was the impact of teacher presence on the social learning climate. Multi-faceted teacher roles supported children's enthusiasm engaging in mathematic discussions. Increased opportunities to discuss mathematics initiated a contagion effect (Becker *et al*. 2014; Burgess *et al.* 2018) triggering excitement, interest, and spontaneous sharing using mathematical language to make real-world connections. Contagion is a relatively under-researched topic in education (Becker *et al.* 2014), and my findings raise questions about the role of contagion as it relates to early years education, warranting a need for further investigation.

Practical Implications

These findings have implications within professional development discourse where teacher effectiveness and student achievement are identified as correlating with career-long professional learning (The Professional Learning Association, 2017). Echoing the ideas of Stigler and Hiebert (2009), it is insufficient to presume teacher professional development will translate into improved practice. Marrying together this idea with findings from my study highlights a need for future professional learning to be presented through the affect-cognition interface, taking into account influences of emotion on teacher capacity to enact new learning and the necessity of support mechanisms to facilitate bridging learning and practice.

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