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Relations Between Third Grade Teachers' Depressive Symptoms and Their Feedback to Students, with Implications for Student Mathematics Achievement

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Abstract

Recent studies have observed connections among teachers' depressive symptoms and student outcomes, however the specific mechanisms through which teachers' mental health characteristics operate in the classroom remain largely unknown. The present study employed student-level observation methods to examine the relations between third-grade teachers' (N=32) depressive symptoms and their academic feedback to students (N=310), and sought to make inferences about how these factors might influence students' mathematics achievement. A novel observational tool, the Teacher Feedback Coding System - Academic (TFCS-A), was used that assesses feedback across two dimensions, teacher affect and instructional strategy, that have been shown to be important to student learning. Multilevel exploratory factor analysis of TFCS-A data suggested two primary factors: positive feedback and neutral/negative feedback. Hierarchical Linear Modeling revealed that positive feedback was related to higher math achievement among students who began the year with weaker math skills, and that teachers who reported more depressive symptoms provided this positive feedback less frequently. Results offer new information about a type of instruction that may be impacted by teachers' depressive symptoms, as well as inform efforts aimed at improving teachers' instructional interactions with students.

Important connections have recently been established among teachers' mental health characteristics and various classroom and student outcomes. For example, McLean and Connor (2015) found that elementary students with weaker initial mathematics skills made less progress in math when their teachers reported more depressive symptoms, and this relation operated through observed classroom quality. Additionally, Sandilos et al. (2015) found that reports of depressive symptoms among preschool teachers were negatively related to the quality of instructional support and organization observed in the classroom. Even in light of these recent findings, the field still lacks a comprehensive understanding of exactly how teachers' mental health characteristics operate within the classroom and in

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relation to the students therein. As such, the primary purpose of this study is to investigate the relations between third grade teachers' depressive symptoms and the nature of their instructional interactions with students, and to make inferences about how these factors might relate to students' academic achievement.

We focus specifically on teachers' feedback to students – a type of instructional interaction that has been shown in past research to be particularly impactful for student learning (Bratcher & Ryan 2003; Hattie, 2008). Providing feedback may require more effort from the teacher than other types of instruction because it is cognitively demanding and requires direct engagement with students (Marshall & Drummond, 2006). As such, we anticipate that a teacher's feedback might be influenced by their depressive symptoms, which have the potential to impact an individual's motivation, energy level, and likelihood of engaging with others (American Psychiatric Association, 2013). In support of our primary study purpose, we created and applied a new classroom observational tool, the Teacher Feedback Coding System – Academic (TFCS–A). Informed by Dynamic Systems Theory (Thelen & Smith, 1998; Yoshikawa & Hsueh, 2001), which illustrates that multiple systems in the classroom interact synergistically to influence students' development, this tool simultaneously captures a teacher's affect and the instructional strategies they employ while providing academic feedback, aspects of instruction we predict will be impacted by depressive symptoms. As this is a new measure, a secondary purpose of this study is to examine the psychometric properties of the TFCS–A and provide preliminary evidence of the tool's predictive validity.

Third grade is a particularly important year because in many states it is the first year that students are formally tested using high-stakes assessments, with students' educational trajectories and teachers' performance evaluations at stake. Recent large-scale evaluations of students across the U.S. paint a disconcerting picture: In 2015, less than 40% of U.S. fourth graders performed proficiently in the core content areas of mathematics, science, and literacy, with mathematics achievement showing a decrease from 2013 (National Assessment of Education Progress, 2015). As such, we identify third grade as an appropriate context for the present study. Results of this effort may help explain more thoroughly how teachers' depressive symptoms operate within the classroom, as well as provide the field with information on potential targets for observation and intervention when attempting to improve the performance of teachers and the outcomes of their students.

Academic Feedback

Teachers and students engage in repeated interactions with each other in the classroom, and these interactions have long been recognized as important contributors to learning (National Research Council, 2005). For example, Rimm-Kaufman et al. (2015) recently reported that higher-quality teacher-student interactions were related to greater student-reported cognitive, emotional and social engagement during instruction. Additionally, Cadima, Leal & Burchinal (2010) found that higher-quality teacher-student interactions were positively associated with first graders' vocabulary and print knowledge skills. This study also reported that associations between teacher-student interactions and student achievement were, in some cases, dependent on students' own characteristics: students who displayed lower math

skills showed greater gains when they experienced more high-quality interactions with teachers.

Teachers' academic feedback is a type of instructional interaction that is especially predictive of student learning (Hattie, 2008). In a foundational study synthesizing findings from over 300 meta-analyses on factors influencing student achievement (Hattie, 1999), teacher feedback was identified as one of the top 10 (out of over 100) most influential factors. However, more recent reports (Hattie & Timperley, 2007) have shown that while feedback is indeed important, the type of feedback provided and the way it is communicated by the teacher can lead to different student outcomes. Specifically, this report identifies feedback that is positive and that provides more, rather than less, information to the student as particularly effective in improving students' learning.

Past literature suggests that delivering this high-quality academic feedback places a greater demand on teachers compared to other types of instruction because it requires a teacher to assess and respond to the learning of individual students "in real time" (Marshall & Drummond, 2006). From the students' perspective, we anticipate that feedback is particularly impactful because it has the potential not only to influence academic learning, but also the social/emotional and relational outcomes and experiences in the classroom. More specifically, because feedback involves an element of judgement by the teacher of a student's perceived knowledge and/or performance, how the teacher communicates this information could have implications for the student's self-esteem and learning-related self-efficacy, what and how much they learn, as well as for the quality of the teacher/student relationship and the interactions/relationships among student peers in the classroom.

The present study involves the simultaneous evaluation of teachers' affect and the instructional strategies they use while providing academic feedback to students. Positive teacher affect has been shown to be important to students' learning and school adjustment; Kiuru et al. (2016) recently found that positive teacher affect in first grade acted as a protective factor against adjustment problems for students. Other studies have revealed positive relations among teachers' affect and their own content knowledge and instructional quality, especially in mathematics (Cross, 2009). In addition to affect, teachers can (and do) employ a range of strategies while providing academic instruction, with some strategies more effective than others (Brophy & Good, 1986). For example, and mirroring findings introduced above, it has been found that feedback that provides ample learning-related information (*elaborative* feedback) is more strongly related to student success than feedback that contains little information (also see Kluger & DeNisi, 1996). Illustrating the importance of considering both affect and instructional strategy in tandem within the same observational tool, a large study conducted among 800 U.S. classrooms revealed that students were more engaged in learning opportunities when their teachers provided high levels of both emotional and instructional support (NICHD ECCRN, 2002). As such, we hypothesize that feedback characterized by both positive affect and more elaborative instructional strategies will be related to higher student achievement in mathematics.

Importantly, past studies have illustrated that teachers' interactions with their young students also depend in part on the characteristics of the students themselves (De Boer, Bosker, &

van der Werf, 2010; Hinnant, O'Brien, & Ghazarian, 2009). Specifically, students' socioeconomic status (SES) and academic performance have been identified as two characteristics that relate to teachers' expectations for students' performance in the classroom and resulting achievement (Auwarter & Aruguete, 2010; Hughes & Kwok, 2007). In general, teachers tend to perceive their higher-SES and higher-achieving students more favorably and are more motivated to interact with and support these students, while their motivation to "reach" lower-SES, lower-achieving students (perhaps through more positive, elaborative feedback) may be dampened (Diamond & Spillane, 2004). This illustrates that a teachers' provision of feedback may too depend in part on the characteristics of the students that teacher is interacting with. As such, we investigate interaction effects that inform whether the types and amounts of feedback provided by teachers depends on students' initial academic performance, as well as include students' SES and initial academic performance as statistical controls in order to strengthen inferences that any results detected can be reliably attributed to the variables of focus in the present study.

Teachers' Depressive Symptoms

Teaching has been identified as one of the most stressful occupations in the U.S. (Johnson et al., 2005; Travers, 2001), with high levels of burnout and job-related stress standing out as common experiences among teachers (Loeb, Darling-Hammond, & Luczak, 2005; Montgomery & Rupp, 2005). Many of the challenges reported by educators including low self-esteem and self-efficacy, chronic fatigue and stress, and challenges with emotion management are symptoms of clinical depression (APA, 2013) and have been found to be highly inter-correlated among teacher samples (Ferguson, Frost & Hall, 2012; Steinhardt, Smith-Jaggars, Faulk & Gloria, 2011). In fact, Whitaker, Becker, Herman and Gooze (2013) recently observed that reports of poor mental health were more prevalent among educators than in the general population, highlighting the importance of conducting mental health research among teachers.

Clinical depression is recognized by the DSM-V as a disabling condition that adversely affects all aspects of a persons' life, including their professional performance and the nature of their interactions with others (APA, 2013). In particular, clinical depression is associated with feelings of fatigue, worthlessness, withdrawal, and a dampening of positive affect (APA, 2013). Whereas there is extensive research surrounding the adverse effects of maternal depression on child development, fewer efforts have examined the impacts of teachers' depressive symptoms on the students they regularly interact with, although this topic has garnered more attention in recent years. Importantly, Hamre and Pianta (2004) found that non-parental caregivers who reported more depressive symptoms were less sensitive and more withdrawn in their interactions with young children. These findings suggest that the negative impacts of maternal depression may be reflected in the relationships that students have with their teachers, and that this may be observed in the individual interactions (such as feedback) that take place between teachers and students during classroom instruction.

It has been found that teachers who report experiencing symptoms of depression display a diminished capacity to positively engage with students and apply high-quality instruction

(Chang, 2009; Roeser, Skinner, Beers & Jennings, 2012), the two aspects of instructional interactions captured by the TFCS–A. For example, Li-Grining et al. (2010) observed a negative relation between personal stress in teachers and their ability to successfully manage student behavior, as well as their ability to foster positive classroom interactions. Additionally, Raver and colleagues (2008) found that teachers who struggled with emotion regulation were less able to monitor multiple classroom factors simultaneously, resulting in a more chaotic classroom environment. These findings, considered along with the fatigue, tendency to withdrawal, and dampening of positive affect characteristic of clinical depression and the "high demand" nature of feedback lead us to predict that teachers with more symptoms will display positive affect less frequently, as well as will employ elaborative instructional strategies less frequently when providing feedback to students.

Study Aims and Hypotheses

The aims of this study are as follows: first, to conduct a preliminary investigation into the psychometric properties of the TFCS–A in order establish its reliability and to best describe the resulting data in terms of factor structure. Second, to investigate the potential relation between teachers' feedback and students' mathematics achievement. Third, to investigate the potential relation between teachers' self-reported depressive symptoms and the types of feedback they provide to students. Regarding aim 1, we anticipate that individual feedback codes will be indicated by larger factors that will be differentiated by positive vs. negative affect as well as by simplistic vs. elaborative feedback strategies. Regarding aim 2, we anticipate that more positive and elaborative feedback will be positively related to students' math outcomes, and (informed by findings from Cadima, Leal & Burchinal, 2010) that this relation will be especially strong for students who begin the year with weaker math skills. Lastly, regarding aim 3, we predict that as teachers' reports of depressive symptoms increase, their likelihood of providing elaborative and positive feedback to students will decrease. By establishing connections between teachers' feedback and student achievement, and between teachers' depressive symptoms and the feedback they provide, this study has the potential to offer information about more specific classroom mechanisms that may be contributing to the previously established relations between depressive symptoms, more broadly observed classroom quality, and student achievement (McLean & Connor, 2015).

Methods

Participants

Students were recruited as first graders to participate in a longitudinal study that began in 2008/2009 and investigated classroom instruction and student achievement in early elementary contexts (Authors, 2013). Data for the present study were collected in 2010/2011 when students were in third grade. Eight to twelve students per classroom across 32 classrooms were randomly selected as target students from strata based on fall literacy and mathematics performance (low, average and high-achieving students), resulting in a final sample of 310 students. Of these participants, 49% were female, 72% were Caucasian, 6% were African American, 4% were Asian, 3% were Hispanic and the remaining 15% were other ethnicities including Native American or Multiracial. Ages of students ranged from 7 to 11 years with a mean age of 8 years, reflecting the typical age of U.S. third grade

students. Forty-seven percent of students qualified for the U.S. Free and Reduced Lunch (FARL) program, a common indicator of low family SES.

Teacher participants were the 32 lead teachers of participating classrooms. Each teacher met state certification requirements and had at least a bachelor's degree in education. Years of teaching experience ranged from 0 to 31 years with a mean of 10.9 years. Two teachers were male and the remaining 30 were female, and the majority (about 92%) were Caucasian. Participating schools presented a wide range of local SES, determined by school-wide percentage of students enrolled the FARL program, with the lowest-SES school displaying 92% student enrollment and the highest-SES school displaying 4% enrollment.

Data Collection Procedures

Three rounds of data collection took place across the 2010/2011 year, once each in the fall (mid-September to mid-October), winter (mid-December to mid-January) and spring (mid-April to mid-May). Student academic achievement was assessed at each of these time points, and the fall and spring student achievement data are utilized in the present study. Video recordings of classroom instruction were captured at each of these time points, and observations of teachers' feedback were conducted using the winter classroom video observations. Teachers reported on their depressive symptoms in the winter.

Measures

Classroom Video Observations—Video observations were captured for 31 of the 32 participating classrooms (one teacher declined to be videotaped), and these videos were used to assess teacher feedback using the TFCS–A. In order to strengthen the internal consistency of this study, only instruction in one content area was assessed. It could be that teachers' instructional practices are context-dependent and so focusing a single subject avoids confounding of results due to content area. As previous findings have revealed relations between teachers' depressive symptoms and students' math, but not literacy, achievement (McLean & Connor, 2015), we focused on mathematics instruction.

Two video cameras were used to capture all classroom activities taking place. Trained videographers managed the cameras as well as wrote physical descriptions of all students present and took detailed notes of classroom activities. Typically, one camera would be used to capture the classroom from a wider viewpoint and the other camera would capture a closer view of the teacher and the students working directly with the teacher. Using this method, all classroom instruction could be accurately captured even when multiple instructional activities were taking place simultaneously. Teachers' time in mathematics instruction ranged from 27 to 80 minutes, with the majority of teachers spending about 60 minutes in math instruction (mean = 60, SD = 11). Total number of minutes spent in math instruction was controlled for in analyses to capture any influence of this variability across observations.

Teachers' Academic Feedback—Academic feedback for 30 of the 32 participating teachers and their 284 students was assessed using the TFCS–A applied to video observation data. In addition to the one teacher that declined videotaping, one classroom was led by a

student teacher during the winter observation and so was not coded for feedback. Missing student data from the 30 classrooms assessed were all due to unforeseen student absences on the day of observation. All other available data for the two teachers and their students not assessed on feedback were used in analyses in order to retain as much statistical power as possible at both levels. The TFCS–A assesses teachers' academic feedback at the student level, meaning that each observed feedback event experienced by a target student is assessed individually. A 'feedback event' is conceptualized within this system as *any instance in which the teacher is providing reactive commentary on a students' academic performance and/or understanding*. This system utilizes frequency coding, in which every observed feedback event is individually documented and assigned a code representing both affect and strategy. Of note, this system does not utilize duration coding in which the start and end times of each event are recorded to capture students' time exposed to feedback. Rather, the number of each type of feedback event experienced by each student is the variable of interest.

Each individual feedback event is assessed across two domains, instructional strategy and teacher affect. Instructional strategy captures the level of detail and effort put forth by the teacher during the feedback event, and three individual strategies are identified: 1) Identifications, in which the teacher notices and points out that a student has made a mistake, 2) Corrections, in which the teacher provides the correct information to a student but does not include any further explanation and 3) Elaborations, in which the teacher provides a more detailed explanation of the students' mistake and/or the corrected information. Teacher affect is evaluated based on the facial expressions, vocal tones, body posturing, and body movements displayed by the teacher during a feedback event, and can be characterized by one of five affect ratings: 1) Enthusiastic/exuberant, in which the teacher is excited, highly engaged, and providing exaggerated vocal tones, words and/or body movements, 2) Content, in which the teacher is relaxed, happy, engaged with the student(s) but tones/movements are not exaggerated, 3) Flat/neutral, in which the teacher is displaying neither positive nor negative characteristics, may be engaged with students but is doing so without any discernable emotion, or may appear to be disengaged 4), Sad/depressed, characterized by low energy, slow movements and low, sad vocal tones and 5) Angry/ frustrated, in which the teacher is visibly and audibly irritated, frustrated and/or upset and uses harsh tones, wording and/or body posturing.

There are 15 individual codes within this system representing all possible combinations of affect and instructional strategy. For example, a feedback event may be assigned a code for "Correction, Angry/Frustrated" to denote an individual event in which the teacher recognized a student's mistake, provided the correct information to the student but did not provide any further explanation, and did so with angry/frustrated affect. Variables were created in the data set for each individual code, and the total number of instances for each code observed for each target student level. For example, if a child was observed to receive 4 flat/neutral corrections from their teacher throughout the duration of the observation, they would receive a value of '4' for the Correction – Flat/Neutral variable. Coders went through approximately two weeks of training using video observations from a different study, and this training included a detailed introduction to general classroom observation methods, introduction to the TFCS–A, and group and individual/trainer discussions of each code.

After training, coders reached a code-level percent agreement of 81% and an inter-rater reliability estimate (Cohen's Kappa; Landis and Koch, 1977) of .76 on a randomly selected 10% of the present study's video observations (3 videos).

Teachers' Depressive Symptoms—Twenty-seven of the 32 participating teachers completed an adapted version of the Center for Epidemiologic Studies Depression Scale (CES-D; see Radloff, 1977 for scoring procedures and clinical cutoffs of the original scale; alpha = .85) in the winter of 2010. Again, all other available data for teachers not assessed on depressive symptoms were used in analyses in order to retain as much power as possible at the teacher level. The CES-D is comprised of 20 questions that ask subjects to report the frequency of their depressive symptoms. The adapted measure utilized in the present study included 18 of the 20 questions in a larger survey of teachers' experiences to alleviate school principal concerns about teachers' sensitivity to completing a formal measure of depression, and two of the 20 questions were excluded at the request of school principals. Teachers were asked to report on the frequency of each of the 18 symptoms presented on a 5-point likert scale, with a score of '1' indicating complete absence of a symptom and a '5' indicating constant presence of a symptom. CES-D questions were scored separately from other survey questions to determine each teacher's level of self-reported symptomatology. Scores on this adapted measure can range from 18 to 90, and observed scores among the teacher sample ranged from 22 to 62, with higher scores indicating more frequent symptoms. The adapted measure displayed acceptable reliability within this sample at alpha = .75.

Student Mathematics Achievement—Students' math achievement was measured using the Woodcock-Johnson III (Woodcock, McGrew & Mather, 2001) Math Fluency and Applied Problems subtests. In the fall, 281 and in the spring, 278 students received mathematics assessments, with missing data due to unforeseen student absences on the testing occasion and follow-up attempts, or to family relocations during the study. The Math Fluency test asks students to perform foundational math functions (addition, subtraction, and multiplication) with increasing difficulty, and has shown high reliability at alpha = .90 (McGrew & Woodcock, 2001). The Applied Problems test presents students with word problems of increasing difficulty, and has shown high reliability at alpha = .93 (McGrew & Woodcock, 2001).

Analytic Approach

A multileveled approach to analyses was deemed most appropriate given the nested structure of the data, with students grouped in classrooms. Multilevel Exploratory Factor Analysis (ML–EFA) in MPlus (Muthen & Muthen, 2007) was performed to address aim 1 regarding the factor structure of the TFCS–A data. Exploratory, rather than confirmatory, factor analysis is widely considered the most appropriate approach in the early stages of measure development when an underlying theory of factor structure has not been established (Gerbing & Hamilton, 1996; Hurley et al., 1997), as was the case here. Oblique rotation, which assumes variables are correlated, was utilized. Code-level variables that were never observed across classroom video observations were trimmed prior to performing factor analysis, and these included "Correction, Sad/Depressed" and "Elaboration, Sad/Depressed". Factor analysis was performed with a two-stage approach, first at the code level

to inform the potential aggregation of TFCS–A variables and again with aggregated variables to make more solid inferences about the factor structure of the data. Once factors of the TFCS–A were determined, bivariate correlations were run to investigate the relations among feedback factors, students' math achievement, and teachers' depressive symptoms.

Hierarchical Linear Modeling (HLM; Raudenbush & Bryk, 2002) was utilized to address Aims 2 and 3 regarding the relations between teacher feedback and student achievement and between teachers' depressive symptoms and their feedback. Unconditional two-level HLM models were first run on all level-1 variables to ascertain the proportions of variance attributable to each level of the data. Two-level predictive HLM models were then utilized to investigate each aim. The first predictive HLM model tested the relations between both positive and negative feedback on student math achievement (all level-1 variables), and this model was later expanded to include a fall math-by-feedback interaction effect to ascertain whether the associations between each type of feedback on end-of-year achievement depended on students' initial math performance. In this model, a significant interaction effect would signify the expected change in spring math achievement for every 1-unit increase in feedback at varying levels (-1 SD, average, +1 SD) of fall math achievement. The second predictive HLM model tested the effects of teachers' depressive symptoms (a level-2 variable) on both positive and negative feedback (both level-1 variables). Student SES and minutes of math instruction were included as covariates in all HLM models. Data were determined to be missing completely at random as evidenced by non-significant correlations between patterns of missing-ness and other variables across all primary study variables, and all HLM models utilized the Maximum Likelihood estimator which provides estimates of the value that was most likely to have resulted in the cases of missing data.

Results

Description and Factor Analysis of TFCS–A Data

Descriptive information for the code-level TFCS–A variables is provided in Table 1 and includes reports of the minimum, maximum and average amounts of each type of feedback received across students, as well as the standard deviation for each. In addition to this descriptive information, we also provide some discussion here of patterns observed across code-level variables: Across all video observations, 893 individual feedback events were identified and assessed with the TFCS–A. Teachers utilized flat/neutral identifications and flat/neutral elaborations the most when providing feedback, with each comprising about 27% of the 893 events (54% total). These were followed by content elaborations (20%), and the remaining 26% of events were spread across the remaining codes with exuberant identifications, corrections and elaborations being observed the least. In examining the feedback strategies teachers utilized without considering affect, 48% were elaborations, 38% were identifications, and the remaining 14% were corrections. Regarding affect alone, teachers displayed flat/neutral affect the most at 65% of events, followed by content affect which comprised about 26% of events. Teachers displayed very little exuberant or sad affect, as well as a small amount of angry affect, and this angry affect occurred mostly during identifications.

Due to the low frequencies of exuberant, sad and angry affect observed, these affect codes were aggregated within each feedback strategy prior to the first ML–EFA. Exuberant and content affect codes were summed within each of the three strategies to represent more general positive affect, and angry and sad affect codes were summed with each other within each strategy to represent more general negative affect. This resulted in nine variables for inclusion in the initial factor analysis: positive, neutral and negative identifications, positive, neutral and negative corrections, and positive, neutral and negative elaborations. Level-2 intra-class correlations (ICCs) were calculated for each of these variables in order to ascertain the amount of variance in each variable attributable to differences between classrooms. With the exceptions of negative corrections and negative elaborations (ICCs .01 and .03, respectively), ICCs for all code-level variables were high, ranging from .44 to .78. These estimates provided further justification for the use of multileveled analytic approaches. As well, correlations between these nine initial variables and minutes spent in math instruction were investigated. Correlation analysis revealed no significant correlations between minutes of math instruction and the initial 9 TFCS – A variables, save for a small negative correlation between minutes of instruction and negative corrections ($r = -.19$, $p < .01$). Again, minutes of math instruction was included in all HLM analyses as a covariate.

Results of the first ML–EFA on the 9 initial variables supported a 4-factor model. The first factor was indicated by the three positive code-level feedback variables, with positive identifications and corrections showing strong factor loadings and positive elaborations showing a comparatively smaller loading. The three remaining factors were indicated by the six neutral and negative code-level variables, which showed consistent cross-loadings across factors with no one factor providing a strong indication of differentiation from the other two. Based on these results, we aggregated neutral and negative affect codes within each feedback strategy and ran a second ML-EFA with these 6 aggregated variables: positive identifications, corrections and elaborations and neutral/negative identifications, corrections and elaborations. Results of this ML-EFA indicated 3 factors, with positive identifications and corrections loading strongly onto a final factor we labeled “positive feedback” and neutral/negative identifications, corrections, and elaborations all loading moderately to strongly onto more general “neutral/negative feedback” (see Table 2). The third factor was indicated only by positive elaborations with a moderately-sized factor loading. Given that the positive elaborative feedback factor was only indicated by one variable, this factor was determined too weak to perform reliable analyses regarding aims 2 and 3 and so further HLM analyses did not utilize this factor.

Teachers’ Depressive Symptoms, Academic Feedback, and Student Math Achievement Variables for Analysis

Factor scores were created for students’ fall and spring mathematics achievement. Student scores on the WJ Applied Problems and Math Fluency subtests both loaded strongly onto one factor, Math Achievement, across both fall and spring, with loadings of .86 for each subtest across both seasons. Code-level feedback data was summed to calculate feedback variables for HLM analysis according to ML–EFA results; with all positive identifications and corrections summed to represent “positive feedback” and all neutral/negative identifications, corrections and elaborations summed to represent “neutral/negative

feedback". Non-normal distributions were detected for both variables, however visual inspections of histograms for the residuals of both variables suggested normal distribution with a mean of 0, indicating no further need to account for variable distribution in analyses. Each feedback variable was group-mean centered for analyses, and teachers' total scores on the CES-D were grand-mean centered.

Descriptive Statistics

Students made expected gains in math from fall to spring and the math achievement factor variable was normally distributed across students (*see* Table 3). Teachers did not report remarkably high frequencies of depressive symptoms, but there was considerable variability across teachers. Teacher-reported scores on this measure ranged from 22 to 62 with a mean score of 36 and a standard deviation of 9. Students received more negative academic feedback than positive. Leve-2 ICCs calculated for the final feedback variables indicated that most of the variability in teachers' feedback was between classrooms, with ICC estimates of .74, and .75 for positive and neutral/negative feedback respectively. Alternately, the level-2 ICC for students' spring math achievement was lower at .12.

Correlation Analyses

Bivariate correlations (*see* Table 4) were run investigating the relations among teachers' depressive symptoms, the two feedback factors, students' fall and spring math outcomes, and the covariates to be included in all HLM models as statistical controls (student SES and minutes of instruction). Positive feedback showed a small negative relation to teachers' reported depressive symptoms ($r = -.18$, $p<.01$) but did not correlate significantly with students' fall or spring math achievement. Neutral/negative feedback was not correlated with teachers' depressive symptoms, but showed a small negative relation to students' fall math performance ($r = -.14$, $p <.05$). Further, positive feedback showed a small negative correlation with neutral/negative feedback ($r = -.16$, $p<.01$). Regarding the two study covariates, students' SES showed a small positive correlation with teachers' depressive symptoms ($r = .14$, $p<.05$) as well as small negative correlations with students' fall and spring mathematics achievement ($r = -.14$, $p<.05$ for fall math; $r = -.21$, $p<.01$ for spring math). Lastly, minutes of math instruction showed small positive correlations with students' fall and spring mathematics achievement ($r = .13$, $p<.05$ for fall math; $r = .15$, $p<.05$ for spring math), but showed no relations to either type of feedback or to teachers' depressive symptoms.

Academic Feedback and Student Math Achievement

The initial HLM model exploring the relation between both positive and neutral/negative feedback and students' spring math achievement revealed no significant main effects of either type of feedback. The next model, which included students' fall math skills as a moderator, revealed a significant interaction between students' fall math skills and positive feedback such that students who showed weaker math performance in the fall made greater gains by the end of the year when they received more frequent positive feedback (*see* Table 5 and Figure 1). The effect size of this relation, interpreted as the proportion of reduction in unexplained variance attributable to the introductions of the main effect and interaction

effects (which included students' fall math performance) into the model, was .63 or 63%. No interaction effects were detected for neutral/negative academic feedback.

Teachers' Depressive Symptoms and Academic Feedback

HLM analysis with teacher's depressive symptoms predicting positive and neutral/negative feedback directed to students revealed a significant main effect of teachers' depressive symptoms on the amount of positive feedback received by students. As teachers' reports of depressive symptoms increased, the frequency of positive feedback received by students decreased (*see* Table 6). The effect size of this relation was .30 or 30%. No effects of teachers' depressive symptoms on neutral/negative academic feedback were detected.

Discussion

This study applied the TFCS–A, a new student-level observational tool, to explore the relations among teachers' depressive symptoms and their academic feedback to students and to make inferences about how these factors might relate to students' mathematics achievement. We first sought to determine how best to represent the data gathered by the TFCS–A, and hypothesized that code-level data would best be categorized by more positive vs. more negative teacher affect as well as by more simplistic vs. more elaborative feedback strategies. This was partially supported as teachers' affect was differentiated as either positive or negative, but teachers' instructional strategies were generally not found to be significantly distinct from one another. An exception to this is that positive elaborative feedback did show some possible differentiation from the more simplistic types of positive feedback in that it loaded onto a third factor, however this single loading did not result in a strong enough factor to be reliably tested in HLM analyses. Additionally, in our investigation of the relations between feedback and student achievement, we anticipated that more positive and elaborative feedback would be positively related to student math outcomes, especially for students who were already struggling in math. This hypothesis was also partially supported: while main effects of positive feedback on student achievement were not detected, an interaction effect revealed that more frequent positive feedback was positively related to the end-of-year math performance of students who displayed lower initial math achievement. Finally, we predicted that teachers reporting more depressive symptoms would provide positive and elaborative feedback less frequently. This prediction was partially confirmed in analyses: as teachers' reports of depressive symptoms increased, the frequency with which they provided positive feedback to students decreased.

Some patterns observed in the code-level TFCS–A data warrant discussion. First, content and flat/neutral affect types were observed with much more frequency than the other affect types, with flat/neutral affect the most frequently observed. While the distinction between these two types of affect may seem subtle, subsequent analyses did suggest an important difference between the two in terms of their relations to student outcomes, with content affect contributing to the type of feedback found to be positively associated with outcomes of students with weaker initial math skills. This observation could be a guide for teachers to attend to the perhaps more subtle components of affect they may be expressing to students. In contrast, very few feedback events were found to be enthusiastic/exuberant, sad/depressed or angry/frustrated, with no observations of sad/depressed corrections or elaborations. As

these affect types are comparatively more extreme in terms of their emotional expressivity, this could indicate that teachers are generally able to regulate their more extreme emotions to a certain extent while they are providing feedback. Alternatively, it could also be that a teacher who is experiencing these more extreme emotions is less likely to provide students with feedback on their academic performance. Within this finding it was observed that the majority of angry/frustrated and all of the sad/depressed feedback events observed were identifications (no sad/depressed corrections or elaborations were observed). A preliminary interpretation of this could be that when teachers are experiencing these more extreme negative emotions, they are less likely to provide a student with more information when an academic mistake is made, opting instead to simply point out the mistake. Importantly though, these observations are very preliminary and so no strong claims can be made.

ML – EFA suggested that these individual codes did indeed group consistently based on teachers' affect as was predicted, however feedback strategy did not play as strong of a role as was predicted in the formation of factors. While there was some evidence of differentiation between more simplistic and more elaborative positive feedback, this differentiation was not strong enough to be considered in formal analyses. However, it does provide some direction for future investigation: we put forth that these findings suggest that a more nuanced evaluation of strategy than was offered in this version of the TFCS–A may be needed for strategy to be reliably categorized along with affect. For example, coders offered that a large portion of positive elaborations observed were instances of teachers using guided questioning to aid students in coming to a correct answer on their own when a mistake had been made, whereas negative elaborations typically involved the straightforward communication of information by the teacher. This guided questioning is an example of an additional instructional strategy that could be included in future iterations of the TFCS–A and might expand this system's ability to capture the various instructional strategies that teachers implement while giving feedback.

Regarding the relations among teachers' feedback and students' math achievement, a significant interaction was detected whereby students who began the year with weaker math skills showed greater gains when they experienced more positive academic feedback from their teacher. This finding provides preliminary evidence of the predictive validity (Ochs, 1979) of the TFCS–A, though future iterations may show a greater capacity of this system to capture how teachers' academic feedback relates to student outcomes. Additionally, this finding extends past studies that suggest that students who are academically at-risk may be particularly vulnerable to the effects of teacher-driven factors (Cadima, Leal & Burchinal, 2010) and personal characteristics (McLean & Connor, 2015). As such, it appears that students in the present study who had weaker math skills may have been especially sensitive to their teachers' affect during feedback events, aligning with our prior conceptualization of feedback as potentially more delicate than other types of instruction. Additionally, it could be that the teachers who were the most effective at fostering academic growth among students at-risk for underachievement tended to apply positive feedback to these students more often, resulting in improved math skills.

Lastly, it was observed that students of teachers reporting more depressive symptoms experienced positive feedback less frequently. Considering this type of feedback was found

to be positively related to underachieving students' mathematics performance, this finding aligns with past reports that academically at-risk students in classrooms with teachers reporting more symptoms generally achieve at lower levels (McLean & Connor, 2015). Findings of the present study suggest that a potential mechanism behind the relation between teachers' depressive symptoms and at-risk students' achievement may be a tendency of teachers with more symptoms to under-utilize instructional practices (positive feedback) that are particularly effective for at-risk students, however this remains to be formally tested.

Limitations and Future Directions

There are aspects of this study that may have limited the generalizability of findings and that should be considered when interpreting results. First, data regarding teachers' academic feedback and reports of depressive symptoms were limited to one time-point, the winter. This time point was chosen in an attempt to capture the most stable period of the school year (Pianta & Hamre, 2009), however the consideration of multiple time points in future work could add important information about how depressive symptoms, and their effects, change across a school year. As well, teachers were assessed on a portion of their instruction (mathematics) provided on a single day, again limiting generalizability of results to all instruction that takes place within a typical classroom. It could be that teachers' provision of academic feedback varies depending on the time of year or on the subject being taught (another potential direction for future research), although constraining the evaluation of feedback to one subject does strengthen this study's internal consistency. It is also important to note is that our study design and analyses were correlational in nature and so no causal claims can be made regarding how variables relate to each other. In the future, a randomized control trial with teachers randomly assigned to mental health support might yield valuable information on the mechanism of teachers' instructional practices, as well as student outcomes.

In addition, while the sample of the present study included an adequate number of student participants, the number of teacher participants was small, thus limiting our power at level-2 and increasing the chance of type 1 error. As such, it is encouraging that effects were detected however future studies should attempt to replicate findings among a larger teacher sample. This is especially salient when considering that five of the 32 teacher participants did not complete the measure of depressive symptoms. These teachers may have been characteristically different from those who did complete the survey, for example a teacher experiencing more depressive symptoms could be less likely to respond to data collection attempts, resulting in an underestimation of depressive symptoms. Lastly, the TFCS–A is a new observational tool that still needs further refinement and testing using more rigorous factor analysis (CFA). Even in light of these limitations, we are confident that the findings observed represent a unique contribution to the field that can inform future research on these topics as well as educational policy, intervention, and classroom/teacher observation efforts.

Broader Implications

Our conceptualization of teachers' academic feedback as an instructional strategy that may be particularly impactful for students, and affected by teachers' mental health characteristics, serves to shed light on a recent finding: Roberts, LoCasale-Crouch, Hamre

and Decoster (2016) observed that students who were in classrooms with teachers experiencing more depressive symptoms made fewer gains in social-emotional skills, and initially hypothesized that this relation would be mediated by the nature of teacher-student interactions. However, no relation between teachers' depressive symptoms and their interactions with students was detected. Considering this along with the findings of the present study, it could be that the relation between teachers' depressive symptoms and the interactions they have with students exists only in certain contexts, such as academic feedback, rather than applying to teacher-student interactions more generally. We hypothesized that feedback, which involves the direct judgement by the teacher of a student's performance and/or understanding as well as requires marked effort on the part of the teacher, may be a particularly sensitive type of instruction. On the part of the student, and especially a student already struggling academically, how messages of feedback are communicated by the teacher could have implications for that students' own self-concept, confidence, learning-related efficacy and perhaps most importantly for the teacher-student relationship, all factors that contribute to students' eventual learning outcomes. On the part of the teacher, the energy, motivation, and higher-order cognitive functioning needed to attend to students' progressing learning and apply high-quality feedback when needed (including a high level of personal engagement with a student) may be impeded by the presence of depressive symptoms. As such, academic feedback may be a type of instruction that carries more weight in its relations to students' outcomes and teachers' mental health characteristics.

Regarding best practices in elementary education, these results suggest that the purposeful application of positive feedback may be particularly effective for students who are at-risk for academic underachievement. This information contributes to a body of work that has attempted to identify how teachers can best individualize instruction based on their students' own learning needs and characteristics (Connor et al., 2009; 2013; 2014), and has generally found that an individualized approach improves student learning. Drawing from the present study, teachers who are attempting to optimize the instructional interactions that they have with individual students could consider each student's prior academic performance and use this information to guide their provision of feedback, making a pointed effort to remain positive when providing feedback to at-risk students.

The findings observed here can also inform the implementation of instructional interventions meant to bolster teachers' instructional quality in the interest of improving student learning. Indeed, the high proportions of variance observed between teachers, rather than between students, in teachers' feedback suggest that teachers' feedback patterns are more dependent on their own characteristics rather than on characteristics of the students receiving them. As such, targeting feedback may be a particularly effective approach for teacher-level instructional interventions. By helping teachers identify their own patterns of feedback, for example becoming more aware of their affect, and by aiding teachers in identifying students who may need more of certain types of feedback (individualizing instruction), systems of teacher training that integrate these findings could ensure that teachers are doing all they can to meet the unique needs of each student in the classroom.

Results of this study also serve to inform systems of teacher and classroom observation. Because research has shown that there is limited consistency or precision in the evaluation of teachers and classrooms (Strong, Gargani & Hacifazlioğlu, 2011), there is an abundant need for research-proven recommendations of what to look for when observing a classroom, especially given the extreme implications of such assessments on teacher outcomes on factors such as compensation and job security. This study indicates that those assessing teachers should look for academic feedback that is positive in nature as evidence of more effective teaching.

Lastly, this study reveals some of the ways that teachers experiencing more frequent depressive symptoms may differ in their instructional interactions with students, contributing to the currently limited knowledge of how these characteristics operate within the classroom to influence student experiences and outcomes. This information can inform steps that might be taken to improve the experiences and outcomes of both teachers and their students in the classroom, for example the implementation of large-scale systems of targeted mental health support for teachers. Such systems would not only benefit educators struggling with emotional well-being, but could likely improve the classroom learning experiences and developmental outcomes of their young students.

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Impact and Implications

This study utilized a novel observational tool, The Teacher Feedback Coding System – Academic, to explore the relations between teachers' feedback and student math achievement, and to investigate how teachers' depressive symptoms relate to the feedback they provide. Findings revealed that feedback characterized by positive teacher affect benefitted low-achieving students, and that teachers experiencing more depressive symptoms were less likely to provide this positive feedback. Results speak to the mechanisms through which teachers' mental health characteristics impact students, as well as inform interventions and policies aimed at improving teachers' instructional interactions with students.

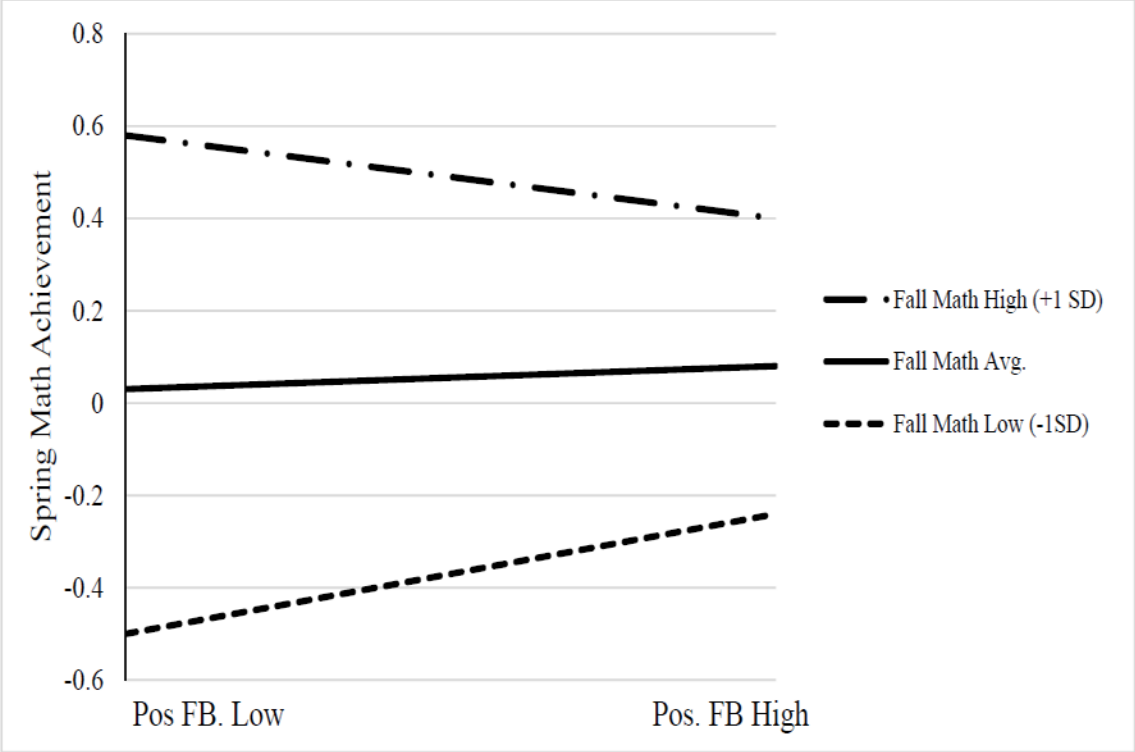

Figure 1.
Fall math X positive feedback interaction effect. Students who began the year with below-average math skills and who received more positive feedback showed higher spring math scores.

Table 1

Descriptive information for initial TFCS – A data.

	Min.	Max.	Mean	SD
Pos. ID	0	3	.20	.51
Nu. ID	0	7	.85	1.13
Neg. ID	0	3	.15	.51
Pos. Correct	0	2	.08	.30
Nu. Correct	0	3	.35	.63
Neg. Correct	0	1	.02	.14
Pos. Elab.	0	7	.64	1.27
Nu. Elab.	0	8	.84	1.71
Neg. Elab.	0	3	.02	.20

Note. Pos. = Positive, Nu. = Neutral, Neg. = Negative, ID = Identification, Correct = Correction, Elab. = Elaboration.

Table 2

Factor loadings for final TFCS – A factors

	Positive Feedback	Neutral/Negative Feedback	3rd Factor (not investigated)
Pos. ID	**.58**	-.08	.16
Pos. Correct	**.84**	-.08	-.11
Pos. Elab.	.15	.02	**.41**
N/N ID	-.14	**.99**	.08
N/N Correct	.01	**.41**	-.41
N/N Elab.	-.14	**.47**	-.13

Note. Pos. = Positive, N/N = Neutral/Negative, ID = Identification, Correct = Correction, Elab. = Elaboration.

Table 3

Descriptive information for all analytic variables.

	N	Min	Max	Mean	SD
CES-D	27	22	62	35.8	9.1
Fall Math	281	-3.1	2.5	.02	1.03
Spring Math	278	-3.7	2.5	.01	1.02
Pos. FB	284	0	4	.3	.7
N/N FB	284	0	16	2.3	3.1

Note: CES-D = Center for Epidemiologic Studies – Depression Scale, Fall Math = Fall Math Factor Score, Spring Math = Spring Math Factor Score, Pos. FB = Positive Feedback, N/N FB = Neutral/ Negative Feedback.

Table 4

Correlations among analytic variables.

	1	2	4	5	6	7
1. CES-D	1					
2. Pos. FB	-.18**	1				
4. N/N FB	-.04	-.16**	1			
5. Fall Math	-.05	-.07	-.14*	1		
6. Spring Math	-.09	-.03	-.12	.83**	1	
7. SES	.14*	.03	.09	-.14*	-.21**	1
8. Mins. Inst.	.08	-.08	-.03	.13*	.15*	-.01

* Correlation is significant at the < .05 level

** Correlation is significant at the < .001 level

Note: CES-D = Center for Epidemiologic Studies – Depression Scale, Pos. FB = Positive Feedback, N/N FB = Neutral/Negative Feedback, Fall Math = Fall Math Factor Score, Spring Math = Spring Math Factor Score, SES = Student Socioeconomic Status, Mins. Inst. = Minutes of Instruction.

Table 5

HLM model estimates for positive and negative feedback predicting student spring math outcomes moderated by student fall math performance.

Fixed Effect	**Coefficient**	**Standard error**	***t*-ratio**	**Approx. d.f.**	***p*-value**
Spring Math (fitted mean)	.05	.08	.64	21	.53
Fall Math effect	.77	.04	17.49	175	<.01
Mins. Inst. effect	.004	.01	.78	21	.44
SES effect	-.001	.05	-.04	21	.97
Pos. FB effect	.07	.05	1.4	175	.16
N/N FB effect	-.02	.02	-1.06	175	.29
Fall Math X Pos. FB	-.27	.1	-2.54	175	.01
Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, u0	.23	.05	21	54.61	<.01
level-1, r	.52	.28			

Note: Pos. FB = Positive Feedback, N/N FB = Neutral/Negative Feedback, Fall Math = Fall Math Factor Score, Spring Math = Spring Math Factor Score, SES = Student Socioeconomic Status, Mins. Inst. = Minutes of Instruction.

Table 6

HLM model estimates for depressive symptoms predicting positive and negative feedback provided to students.

Fixed Effect	**Coefficient**	**Standard error**	***t*-ratio**	**Approx. *d.f.***	***p*-value**
Pos. FB (group mean)	.23	.07	3.17	21	<.01
Mins. Inst. effect	-.004	.01	-.8	21	.43
SES effect	.05	.05	1.03	21	.3
CES-D effect	-.02	.01	-2.84	21	<.01
N/N FB (group mean)	.01	.01	-2.72	21	<.01
Mins. Inst. effect	<.001	.03	-.01	21	.99
SES effect	<.001	.03	.20	21	.84
CES-D effect	-.00	.00	-.02	21	.98
Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, u0	.004	.00	21	6.09	<.5
level-1, r	.74	0.56			

Note: Pos. FB = Positive Feedback, N/N FB = Neutral/Negative Feedback, CES-D = Center for Epidemiologic Studies – Depression Scale, SES = Student Socioeconomic Status, Mins. Inst. = Minutes of Instruction.