ACTIONS SPEAK LOUDER THAN WORDS: HOW SHOULD ATTRIBUTIONAL FEEDBACK BE COMMUNICATED TO STUDENTS IN CLASSROOMS FOR THE MOST ACHIEVEMENT GAIN IN MATHEMATICS?

by

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A Dissertation Submitted to the Faculty of the

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

In Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

2015
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ACKNOWLEDGEMENT

This study would have not been possible without the love and support of my family, friends, faculty mentors, and coffee beans all over the world. In full gratitude I would like to thank my beloved mother and father who although thousands of miles away I could feel their presence in every single stage of my life with their unconditional love and support over Skype and phone.

I would like to express the deepest appreciation to my advisor Professor Mary McCaslin, who has the attitude and substance of a genius: she continually and convincingly conveyed a spirit of persistence and courage in both my academic and personal life and believed in me throughout this whole graduate journey. I will never forget the phrase “it’s a learning process, try to enjoy it” that she said in our very first meeting, which stayed with me throughout my graduate career and changed my whole perspective towards learning and academic growth. I am fortunate and honored to call her a mentor and a friend.

Thank you to my committee members, Dr. Heidi Burross and Dr. Francesca Lopez for their encouragement, inspiration, support, and assistance in my pursuit of a high education degree.

In addition, a thank you to Dr. Nicole Kersting for welcoming me into her laboratory and research and for her guidance and time in considering matters big and small.
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Abstract

While the role of attributional feedback on student learning and achievement has been previously studied in laboratory settings, the importance of these types of feedback in real-time classroom settings is yet to be examined. This study attempted at exploring whether attributional feedback is present in interactions between teachers and students in natural classroom settings and how much they contribute to students’ achievement in mathematics. Using an observational coding system, 55 one hour mathematics classrooms were coded for three different types of attributional feedback: direct attributional feedback, indirect attributional feedback, and strategy feedback. Direct attributional feedback consisted of explicit statements that were effort-oriented, ability-oriented, or knowing-oriented. Indirect attributional feedback consisted of teacher behavior that implicitly conveyed attributional messages to students. Behaviors such as unsolicited offers of help, giving credit to students, abandoning students, and calling out student name publicly were coded as indirect attributional behavior in this study. In addition, “why”, “how”, “what” strategy questions and strategy statements were coded as strategy feedback in this study. The results of this study indicated that while both direct and indirect attributional feedback are present in natural classroom settings, there is a significant difference between the number of times each type occurs. Teachers are more likely to convey attributional messages to students through indirect behavior compared to explicit attributional statements. When these types of feedback were examined in a model predicting students’ mathematics achievement scores, the results showed that attributional feedback on their own significantly predicted student achievement but when it was combined with strategy feedback a stronger association with achievement scores.
occurred. Amazingly, it should be noted that in this model, direct attributional feedback indicated a negative association with mathematics achievement whereas indirect attributional feedback and strategy feedback indicated a positive association. These findings reveal that attributional feedback play an important role in student achievement in mathematics and the most effective way to present students with these types of feedback is to convey them indirectly and in combination with strategy feedback.
Chapter 1. Introduction

Statement of the Problem

Feedback is one of the major influences on motivation and achievement in classrooms, to the extent that effective feedback is known to enhance teaching and learning (Black & Wiliam, 1998; Crooks, 1988; Hattie, 1999; Sadler, 1989; Tunstall & Gipps, 1996). This major influence of teacher feedback on student motivation and learning could be due to the fact that when teachers develop expectations of their students based on their prior experiences, they start behaving differently towards students. These teacher beliefs are communicated to the student in the classroom through verbal and behavioral feedback and consequently the repetition of such feedback affects students’ self-concept, achievement motivation, and classroom conduct. In turn, students’ performance in class reinforces the teacher’s beliefs, which finally affect student achievement (Brophy & Good, 1970).

One of the theories that has been successful at explaining this give-and-take cycle between teachers and students in classrooms is attribution theory (Weiner, 1979; 1985; 2000). This theory claims that students look for causal explanations for achievement outcomes in terms of ability, effort, task difficulty, and luck in their surroundings and themselves. Students then categorize these causes in three dimensions of stability, internality, and control. One of the main sources for students’ causal search in classrooms is teacher feedback. For example, if the information conveyed by the teacher points to the amount of effort that the student has put for the task, the student categorizes the cause as controllable, unstable, and internal. But if the teacher’s feedback hints to the student’s ability, the cause is perceived to be uncontrollable, stable, and internal. Experimental
research conducted on attributional feedback has found that statements referring to a
student’s level of ability (e.g. “you’re very good at this”) and effort (e.g. “you’re trying
very hard”) at the time of success or failure is linked to student motivation and
achievement (Bryan, Bryan, & Dohrn, 1993; Yasutake, Bryan, & Dohrn, 1996; Schunk,

Previously, classroom research has been conducted on the effect of teacher beliefs
and attributions on student behavior and self-perception but based on vignettes and self-
report (Brophy & Rohrkemper, 1981; Rohrkemper 1984; Brattesani, Weinstein &
Marshall, 1984; Mac Iver 1988; Eccles & Midgley, 1989). Moreover, other methods such
as observational coding have been used to capture the effect of other types of teacher
feedback on student performance in real-time classroom settings (Brophy & Good, 1970;
Rubie-Davies, 2007) but not specifically on attributional feedback. In order to capture
attributional feedback in real-time classroom climate, Foote (1999) examined the types of
feedback statements used by teachers in third grade mathematics classrooms using
observational videotape coding. She found that out of the three types of explicit negative
and positive feedback statements that they coded for (attributional, conduct, and general
feedback), attributional feedback statements were rarely used in the classroom. This
finding may be expected because, in a natural classroom context, teachers typically do
not explicitly direct attributional statements like “You do not have the ability to do this”
at their students. Instead, as Graham and Williams (2009) state “this attributional
information may be subtly, indirectly, and even unknowingly conveyed” (p. 14). Thus,
coding for direct attributional statements in teachers’ feedback might not be the only way
that attributional information is communicated in classrooms.
The type of indirect and implicit attributional feedback that Graham and Williams (2009) talk about was examined in a series of experimental studies (Graham, 1984; Graham, 1990; Graham & Barker, 1990; Kamin & Dweck, 1999; Mueller & Dweck, 1998). These studies have shown that teacher behavior, rather than direct teacher talk, might communicate causal attributions to students. For example, Graham (1990) in his experimental studies was able to distinguish three teacher behaviors that indirectly function as low ability cues: (a) sympathy following failure, (b) praise following success, and (c) unsolicited help especially in easy tasks (Graham, 1990). While the teacher displays these actions and behaviors, the student engages in interpreting the teacher’s attribution and begins ascribing causes to his or her own achievement outcome based on that (Graham & Williams, 2009; Rudolph, Roesch, Greitemeyer, & Weiner, 2004).

**Purpose of the Study**

While there have been various experimental and self-report research studies on the role of attributional feedback on students’ learning and achievement, not many have focused on these types of feedback in real-time classroom settings. Most research studies on attributional feedback effectiveness have been conducted in laboratory settings with experimental interventions and manipulations (Graham, 1984; Graham, 1990; Schunk, 1983, 1984, 1989) or vignette and self-report studies (Brophy & Rohrkemper, 1981; Rohrkemper 1984; Brattesani et al., 1984; Mac Iver 1988; Eccles & Midgley, 1989). Although these types of studies can inform classroom interventions and instructional development, they do not necessarily portray the type of attributional feedback used by teachers in real-time classrooms. Furthermore, there is a lack of evidence that these types of feedback statements lead to the same results outside the laboratory.
According to previous experimental research, we now know that attributional feedback made by teachers in laboratory settings can be communicated in various forms – whether behavioral or verbal, direct or indirect – and still affect students’ motivation and achievement. Nevertheless, the effect of attributional feedback on student achievement in natural classroom settings is yet to be investigated. Hence, this study’s overarching aim is to devise a system to capture attributional feedback in natural classroom settings conveyed by the teacher in various direct and indirect forms and respectively examine its association with student mathematics achievement. For this purpose, I have created an observational coding system that measures different types of attributional feedback and strategies proposed to students by the teacher in classrooms. Subsequently, I examine associations among target observable direct and indirect attributional feedback and how they contribute to students’ mathematics achievement scores. This examination will reveal if there is a difference between how different types of attributional feedback contribute to student mathematics achievement in natural classroom settings. Specifically, I aim to answer the following questions in this study:

1. How frequently do teachers communicate each type of attributional feedback (direct vs. indirect) to students in natural classroom settings? Is there a significant difference between the two?

2. How well does attributional feedback predict achievement in fifth grade mathematics classrooms? How much variance in achievement scores can be explained by each type of feedback?

3. Does accompanying strategy feedback with attributional feedback better predict student achievement in fifth grade mathematics classrooms?
4. Question 4: If we control for the possible effect of teacher’s gender, the recipient of feedback, and context of interaction, can attributional and strategy feedback still explain a significant amount of the variance in mathematics achievement scores?

In the following section I will explain more about attributional feedback through the principles of attribution theory and its link to motivation and achievement. I will also look into the role that these types of feedback play in the development of dispositions in individuals through the Disposition Development Model (Heshmati, 2011).
Chapter 2. Theoretical Background

Attributional Feedback in Weiner’s Attributional Theory of Motivation and Emotion

Attribution theory, as developed over time, from Heider’s (1958) book of *The Psychology of Interpersonal Relations* to Weiner’s *Attributional Theory of Motivation and Emotion* (1986), has been one of the most influential theories in understanding motivation in the everyday school setting. This theory attempts to explain the causal attributions ascribed to one’s outcome either by the self or by others while exploring the affective and behavioral consequences of these attributions. When an outcome of an event is negative, unexpected, or important, individuals begin asking questions like “why did this happen?” and search for causes for that outcome. Factors like past history, social norms, or performance of others could be some of the sources that individuals refer to for the answer to their “why” question. As Weiner (2000) states, success and failure in achievement settings occur in a social context consisted of peers, teachers, and parents that influence and are influenced by students’ achievement performance (Weiner, 2000). From all these influential factors, teacher feedback is the most dominant source of attributional information in classroom settings (Graham & Williams, 2009). Thus, in this section I will explain more about how teachers’ attributional feedback plays a role in students’ causal ascriptions and consequently their motivation and achievement using Weiner’s (1979, 1986, 2000) theory of attribution.

Weiner (2000) looks at attributional theory from two perspectives, an intrapersonal theory of motivation and an interpersonal theory of motivation. The
intrapersonal perspective looks at the attributions that individuals make about their own outcomes and its consequences whereas the interpersonal perspective focuses on people’s attributions as perceivers of others’ outcomes and its consequences. These two systems are known to be interrelated and interactive and influence both the actor’s and the observer’s thoughts, feelings, and actions (Weiner, 2000).

Following an outcome interpreted as success or failure, students after an initial affective reaction of sadness or frustration, start searching for causes to the outcome. In an achievement context, success and failure are usually attributed to factors like ability, effort, strategy, task difficulty, or luck. Each of these factors in turn is associated with three underlying causal dimensions: locus, stability, and controllability, which are related to specific feeling states. The dimension of locus typically influences feelings of pride in accomplishment and self-esteem whereas the combination of the controllability dimension and locus influence the feelings of shame and guilt after failure. These feelings along with expectancy of success consequently determine subsequent behavior.

From an intrapersonal perspective, for example, if a student attributes failure to low ability, she believes that the cause of her failure is internal, meaning it came from within herself and not from an external factor; uncontrollable, meaning it is not subject to volitional change; and stable, meaning it is permanent and cannot change over time. This causal attribution initiates feelings of low self-esteem due to the internal causality, expectancy of failure in the future due to the stable causality, and shame and humiliation due to uncontrollability of the internal cause. These feelings would consequently lead to school dropout, or other negative consequences (Weiner, 1979; 1986; 2000).
From an interpersonal perspective, in the classroom setting, a causal search begins by an involved observer like the teacher after a student’s failure. In this case, the teacher similarly places his perceived cause in the three dimensions with an emphasis on the controllability dimension. If the cause of the failure is perceived to be the student’s lack of effort, which is deemed to be controllable by the student, the teacher then perceives the student as responsible for the outcome. Ergo, the causal attribution leads to an inference about the student’s lack of effort and thus gives rise to the teacher’s emotional response of anger which then leads to behavioral responses such as punishment or reprimand (Weiner, 1979; 1986; 2000).

Knowing that these two attributional perspectives are intertwined (Weiner, 2000), here I want to propose a model that demonstrates the link between the two theories (Figure 1). This model is achieved by combining Weiner’s (2000) two attributional models of intrapersonal and interpersonal motivation (cf. Weiner (2000) for the two distinct models). Based on the two attributional models, we learned that when a negative, unexpected, and/or important event occurs there could be two possible attributional searches going on: one by the actor and one by the observer. At the same time, these two causal attributions could influence and impact each other. In a classroom setting, it would most likely be the student and the teacher who would be taking on the role of the actor and observer although we should keep in mind that peers also do influence these roles and their causal attributions.
Figure 1

Interpersonal and intrapersonal attribution models

Interpersonal

Achievement
Outcome

Intrapersonal

Outcome

Dependent
Affect

Causal Antecedents

Causal Ascription

Psychological Consequences

Behavioral Consequences

Causal Dimension

Behavioral Reaction

Responsibility Antecedent

Cause/Type

Intrapersonal

Outcome

Dependent Affect

Causal Antecedents

Causal Ascription

Psychological Consequences

Behavioral Consequences

Causal Dimension

Behavioral Reaction

Responsibility Antecedent

Cause/Type
Based on Figure 1, this is how the interrelationship of these two attributional searches is played out in a classroom between a teacher and a student. For example, at the time of a student’s failure at a test, both the student and teacher attempt at explaining “why” this outcome occurred. While the student is processing the post-outcome affective state and searching for a reason to his failure, the teacher has come to a conclusion as to the cause of the event and the extent of its controllability by the student. It is at this point when the teacher begins acting upon the inferences he/she has made and either becomes angry, sympathizes with the student, or makes a comment based on her causal attribution. In turn, the teacher’s reactions to the event become one of the main causal antecedents for the student’s causal ascriptions to his own failure in the test. After considering all the sources of evidence, the student comes to his own conclusion about the cause of his failure. Based on the causal dimensions (locus, stability, and controllability) of his attribution, the student feels a sense of pride, shame, guilt, or other affective reactions. These feelings along with the student’s expectancy of success then motivate subsequent actions and future achievement. As learning is not done in isolation, this process recurs in a cycle where students’ behavioral reactions and achievement motivation influence their future achievement outcome and teachers’ further causal ascriptions, hence beginning another attributional cycle for both the student and the teacher in the classroom (cf. Figure 1).

**Attributional Feedback in Disposition Development**

The Disposition Development Model (Figure 2; Heshmati, 2011) is a model that attempts to explain the process of how human behaviors are learned and developed to form dispositions. Dispositions, from a motivational perspective, are defined as recurrent
and emotionally tinged goal-directed implicit preferences for particular qualities of experience, which are believed to direct and select behavior over the course of daily life (McClelland, 1985). In other words, dispositions are human tendencies or implicit preferences that are relatively stable and unconscious and represent affective preferences for each individual. Some examples of disposition include but are not limited to being a curious or indifferent person, judicious or impulsive person, systematic or careless person, or gullible or skeptical person (Ritchhart & Perkins, 2005).

Figure 2

Disposition Development Model
The Disposition Development Model divides disposition development into three phases: Cultural Mediation, Behavior Orientation, and Disposition Formation. The Cultural Mediation phase (Figure 2A-Cultural Mediation) is based on the sociocultural approach of the Vygotskian theory. This process is based on the fact that behavioral outcome is a function of determinants in both the person and the environment. Therefore, thinking and concepts that appear in thought first appear in the thinking of small groups interacting with one another; later these concepts make their way into the individual’s own consciousness which is called “internalization”. Apart from internalizing and deriving meaning of their surroundings, knowing how things work, and acquiring knowledge with the help of others with whom they communicate, individuals also tend to appropriate ways of thinking through these social interactions. “Appropriation” in this model is referred to individuals using the knowledge acquired in a social context and making it unique to themselves (Vygotsky, 1978).

This unique knowledge and perception is then formed into symbolic representations, which in turn, according to Bandura, form motives for future behavior (Goldhaber, 2000). It is at this point that the Behavior Orientation phase (Figure 2B-Behavior Orientation) begins. Motives along with their specific environmental cue values (e.g. thirst sensations have different cues from hunger or fear sensations) energize, orient, and select behavior towards a goal (McClelland, 1985). At this stage, individuals have developed the motivation needed for performing an action. But, in order for the action to occur, Lewin (1935) proposes that individuals evaluate their desire, the reward value of the end state, and the difficulty of achieving the goal. Once these three variables are evaluated, a decision is made about taking action or not (McClelland, 1985). If an
individual decides to take action, he/she goes through a cycle of adaptive learning (McCaslin, 2009).

Adaptive learning is part of the Disposition Formation phase (Figure 2C-Disposition Formation) of the Disposition Development Model. According to McCaslin (2009), an individual acts on oneself and one’s situation to better meet demands, needs, and goals. After producing an action, based on the differential opportunities for each person, the validations from their social surroundings and the challenges they face, they gain more and more experience in time. Consequently, these experiences assist individuals in forming predictions about the outcome of their behaviors (McCaslin, 2009). As more predictions form, expectations are shaped in the human mind. This adaptive learning process, which is a cycle between actions, outcomes, experiences, and expectations, is what leads to the formation of dispositions.

In the process of disposition formation, there comes a time when outcome of actions are not compliant with previously formed expectations. If this happens, individuals begin interpreting their environment and events to see how they relate to their thinking and behavior in such a way as to maintain a positive self-image (Weiner, 1985; 2010). This takes them to the attribution process where individuals begin attributing causes to their unexpected outcome, which I have covered in the previous section.

In this process, feedback and validation received from the social surrounding plays a major role, whether outcome of actions turn out to be in accordance with expectations or not. For example, in an achievement context, if I try hard and succeed, I try hard again and I succeed, and I try hard multiple times and I still succeed, I start
forming the prediction that I will succeed in my work if I try hard enough. While this prediction evolves into an expectation with more experience and trial and error, the social context of the classroom where this event takes place also starts playing a role. Before my predictions develop into expectations and consequently become a tendency and a disposition in me to try hard in every challenge that I face, I pay attention to the feedback I receive from my teacher and peers. If I receive validation from my social surrounding, this is when I accept my prediction to be true and begin developing a disposition of persistence and effortfulness over time with more experience.

This could also be true if I face an unexpected outcome. If after forming an expectation that trying hard would lead to success, I put all my effort into a task and I don’t succeed, I start searching for causes for that unexpected outcome (failure) and fall into the attribution realm. Again, in my causal search, apart from looking for causes in myself and my own actions I will also pay attention to my peers’ and teacher’s reactions and form my causal attributions based on the information communicated to me and act accordingly. This action in turn returns to the adaptive learning cycle to form dispositions.

In conclusion, being in a social life, humans fulfill their social needs through relationships and participation and a sense of belongingness and value for others. It is because of this that other people’s validation comes to their attention in specific opportunities that come up for them and play an important role in forming behavior and reacting to outcomes of life events. Specifically, in an educational context, for students to develop useful habits and tendencies to become successful learners, the types of messages and feedback communicated to them by teachers and peers affect their
evaluation of their learning outcome and consequently the disposition they acquire towards learning and achievement.

**Combination of Attributional Feedback and Task Strategy Feedback**

Having discussed the importance of teachers’ attributional feedback in classrooms from an attributional and disposition development perspective, we have to realize that it is equally important to be able to measure these types of feedback in natural classroom settings in a way that fully captures different types of attributional feedback in all possible ways conveyed to students.

Although there has been an attempt to measure attributional feedback in natural classroom settings (Foote, 1999), this attempt has not been successful in fully finding all the types of feedback that provide attributional information. This could be due to the fact that this research focused solely on explicit and direct attributional phrases that teachers provide students as feedback. From a series of experimental research by Graham and colleagues (Graham, 1984; Graham, 1990; Graham & Barker, 1990) we know that teachers typically do not directly express their causal explanations of failure or success to students. These types of attributional information are often conveyed subtly, indirectly, and sometimes unknowingly through the teachers’ actions and behaviors towards students (Graham & Williams, 2009).

At the same time, from studies focused on attributional feedback, be it ability feedback, effort feedback, or a combination of both (Borkowski, Wehying, & Carr, 1988; Borkowski, Wehying, & Tuner, 1986; Bryan, Bryan, & Dohrn, 1993; Yasutake, Bryan, & Dohrn, 1996; Schunk, 1982, 1983, 1984), Dohrn and Bryan (1994) have concluded that
what makes these types of feedback effective in academic achievement and acquiring adaptive attributions in students is the combination of attributional feedback with teaching task strategies (Dohrn & Bryan, 1994). Hattie and Timperley (2007) have also highlighted the importance of feedback accompanied by task strategies in their review of research on feedback and the evidence related to its impact on achievement. In their meta-analysis, the authors report that studies that measured feedback as consisting of information about a task and strategies about how to do the task in a more effective way showed the highest effect sizes, thus promoting learning and academic achievement better than feedback void of these types of strategies (Hattie & Timperley, 2007).

Therefore, in order to examine the relationship between attributional feedback and student achievement in classrooms, the presence of task strategy feedback should also be taken into consideration.
Chapter 3: Methodology

Sample

The sample used in this study consists of videotaped mathematics classrooms of 57 fifth grade teachers and their students. 74% (n=42) of these teachers are female teachers and 26% (n=15) are male. These teachers were part of a larger study that took place in a large urban district in California. Out of all the teachers 90% (n=51) of the teachers hold multiple subject credentials and 11% (n=6) are National Board Certified Teachers. Teachers’ experience in teaching mathematics ranges from 1 year to 28 years with a mean of 10 years experience (SD=6.52). The number of students in each classroom ranged from 18 to 28 students with a mean of 23 students per classroom.

The duration of the mathematics lessons were approximately one hour long. For this study, one lesson out of the five mathematics lessons videotaped for each teacher was selected adding up to 57 lessons. This selection was based on the amount of time spent on seatwork in each lesson. I picked the lesson with the most amount of seatwork since most of the types of feedback measured for the purpose of this study were more likely to occur during these seatwork activities. All of the mathematics lessons for all teachers were focused on the topic of fractions so there was consistency across the lesson with regards to the topic taught. Out of the 57 classrooms, two had missing student achievement scores so this study only included 55 teachers and their students, for which achievement scores were available.
Observational Coding System

To capture the different types of attributional feedback communicated by teachers to students during mathematical interactions, I developed an observational coding rubric to characterize the types of feedback that were either focused on providing strategies or conveying causal attributions to students. To code these interactions, I first identified interaction episodes that were focused on the teacher interacting with either one or a group of students or with the whole class. After determining the in and out-times of all the teacher-student interaction episodes in a lesson, I then coded each episode for the types of feedback that were communicated to students by the teacher. Below I have provided a thorough description of how these two steps were taken to code observational data for different types of feedback.

Identifying interaction episodes. The interaction episodes captured for this code could be initiated by the teacher or by the student. But no mere student-to-student interactions where the teacher was not present were included in this coding. To be considered as an interaction episode there has to be at least one student contribution that is followed up with teacher feedback. However, interaction episodes can last over several teacher and student turns. In order to understand the context surrounding the student contribution, I included any teacher prompt that may have instigated the contribution and ended at the conclusion of the teacher follow up or whenever the student’s thoughts/ideas are no longer central to the interaction. For each interaction episode an in-time and an out-time was recorded. The in-time starts when either (1) a teacher prompt that instigates a correspondence with student(s) or when (2) a student initiates an interaction with the teacher. In either case, once a student contribution has been observed, any follow up to
the contribution, which in most cases will be teacher-led, is included in that interaction episode. The types of follow up to the contribution ranges from short (“Good” or "Hmmm”) to long (“I’m not quite sure I understood the last part of what you said, could you explain it again or give me an example?” + student addressing teacher’s follow up). The out-time is recorded when all follow up to that specific contribution ends and the teacher moves on to other students. Table 1 illustrates examples of teacher-student interactions captured by this code.

Table 1

*Examples of teacher-student interaction episodes*

| Interaction Episode | Example 1 | T: “Do we add denominators that are different?”  
| |  | S: “No” |
| | Example 2 | T: “What do you notice about the size of the fraction parts and the denominator?”  
| |  | S: “The bigger the denominator, the smaller the fraction parts” |
| | Example 3 | T: “Which fraction is bigger, 3/3 or 4/1?”  
| |  | S: “4/1”  
| |  | T: “Can you show it to me by pictures?”  
| |  | S draws one circle cut into three pieces and colors them all in for 3/3 and one whole circle and colors it all in to demonstrate 4/1.  
| |  | T: “Aren’t the two pictures equal?”  
| |  | S adds three more whole circles for 4/1 and explains that the “1” in the denominator shows that the circles are cut into only one piece and the “4” in the numerator shows there should be 4 whole pieces. So 4/1 is greater than 3/3. |

**Coding for types of feedback.** For the mathematical interaction episodes identified in the first step, I coded for the presence of the following components:
Direct attributional feedback. Direct attributional feedback is referred to statements that explicitly communicate causal attributions to students. For example, statements like “I can tell you are very talented at this” or “Are you trying hard enough?” made by the teacher are types of direct attributional feedback. This category of feedback consists of three subcategories that are coded separately for each interaction episode:

1) **Effort feedback**: Explicit statements that are directed at the amount of effort students have put into their work. This type of attributional statement communicates an internal, controllable, and unstable cause to the event (e.g., “You are doing really well, I appreciate that you are working so hard on this.”)

2) **Ability feedback**: Explicit statements that are directed at the students’ ability or aptitude in the task at hand. This type of attributional statement communicates an internal, uncontrollable, and stable cause to the event (e.g., “You’re not good at this type of a problem, let your friend help you.”)

3) **Knowing feedback**: Explicit statements about the students’ knowledge and understanding of the concepts taught (e.g., “I’m not sure you understand this.” Or “you don’t know how to add this, let me show you.”). Although this subcategory of “knowing” has not been included in the attribution literature before because of the difficulty in determining the underlying causal dimensions, but I believe it is an important component that needs to be captured in this code. Because these types of statements are used often in the classroom contexts, it would be useful to examine their effect on
student mathematics achievement as well. Based on my own presumptions, I would categorize these types of statements as internal, controllable, and stable although this categorization has not been scientifically tested before.

**Indirect attributional feedback.** Indirect attributional feedback is the type of feedback that conveys attributional causes in a subtle and implicit way through teachers’ behaviors and actions towards students. For example, according to Graham (1990), behaviors like sympathy following failure, praise following success at easy tasks, and unsolicited help by the teacher provide indirect attributional information to students. Based on the type of data I have at hand for this study and the information that can be codified, the following subcategories are coded for each interaction episode as indirect attributional feedback:

1) **Unsolicited offers of help:** This type of behavior occurs when students are working independently and the teacher chooses to approach and either help a certain student without him/her asking for it or monitor them while working. This conveys to both the student and other students in the class that the teacher believes this specific student is not capable of working out the problem on his/her own and thus needs assistance/monitoring, which emits the notion of lack of ability. In most cases, this teacher behavior recurs throughout the lesson towards the same student(s).

2) **Giving credit to student:** This type of behavior arises when a student responds correctly to a posed question or problem and the teacher chooses to give the credit of the correct solution to this student by announcing his/her name to the whole
class or a group of students. A typical example of this announcement could be
“Everybody pay attention to Sarah, she has the correct answer” or “Alberto just
told me how to add the two fractions. That’s very impressive.” This behavior is
known to convey high student ability in the task at hand.

3) **Abandoning student:** This type of teacher behavior occurs when a student is either
trying to figure out an answer that he/she doesn’t know or gives a wrong answer
to a prompt and the teacher chooses to move on to the next student or task without
giving that student the opportunity to try again or help the student figure out the
solution, thus abandoning the student. This type of behavior conveys lack of
student ability and the teacher not having faith that student the student is able to
solve the problem given more time and further prompting.

4) **Calling out student name publicly for conduct:** This type of behavior arises when
a student is not on task and is not paying attention to the teacher. In these
instances the teacher calls out the student’s name publicly as opposed to the
teacher just getting student’s attention by privately going to him or even calling
out the whole class instead of a specific name. Through this behavior the teacher
is eliciting embarrassment, which is one of the core emotions elicited when causal
attributions are made. Thus, I deemed it useful to include this type of a behavior
and examine its contribution to student mathematics achievement.

**Strategy feedback.** Acknowledging the importance of the combination of
attributional feedback with information regarding task strategies for a more effective
outcome (Dohrn & Bryan, 1994; Brophy & Good, 1986), a thorough and complete
system of attributional feedback measurement should also search for information
regarding strategy feedback communicated to students. Statements like “Can you think of another way to do this” or “Let’s go one by one” made by the teacher are examples of comments to students hinting on task strategies. These types of comments present information about the task at hand and strategies that could help students tackle the problem in a more effective way. Hence, including these types of strategy statements in our system of attributional feedback measurement is necessary to understand the extent to which teachers communicate helpful task information to students alongside other types of feedback. The following types of statements are included as subcategories for the strategy feedback category:

1) “Why” strategy questions: Questions that start with “why” and also prompt the student(s) to explain why he/she chose a specific strategy to tackle the problem (e.g., “Why did you choose to solve the problem this way?” or “Why did you find a common denominator instead of adding the denominators across?”)

2) “How” strategy questions: Questions that start with “how” and also prompt to student(s) to explain how they reached a specific solution to a problem, explaining his/her strategy (e.g., “How did you get ½?” or “How can I solve this problem using a shorter way?”).

3) “What” and other types of strategy questions: Any other questions that direct the student(s) to a task strategy are coded under this subcategory (e.g., “Can you look at this another way?” or “what is an easier way to do this?” or “Do you think this strategy will work for this problem?”).

4) Strategy statements: Under this subcategory, only statements – not questions – that hint to task strategies are captured (e.g., “I want you to think about another
way you can solve this problem.” or “Start thinking in your mind about how you can explain this without a fraction.”

**General feedback.** These types of feedback include any type of follow up that the teacher makes that does not hint at causal attributions or task strategies. This more general feedback could either be neutral statements (e.g., “ok”, “yes”, “no”, “move to the next problem”) or reassuring statements (e.g., “great job”, “excellent”, “I like what you’re doing.”) and mostly occur during transitions between one interaction to the other.

**Tackling.** Brophy and Good (1970) have argued that tackling a student to extend their thinking compared to giving out the answer to a problem without any further attempts to elicit student thinking is a good indicator of the teacher’s expectancy of students. Teacher’s high or low expectancy of students can in turn communicate high or low ability feedback to them. Thus, based on this claim, it is useful to examine how these types of teacher beliefs contribute to student mathematics achievement. Therefore, the following subcategories are coded for each interaction episode under this category:

1) **Providing response opportunities:** When a student gives out an incorrect answer and the teacher provides the student with opportunities to respond by repeating or paraphrasing the question, or asking new questions to elicit and further students’ thinking until he/she figures out the solution, it means that the teacher has high expectancy of that student. Having high expectancy of a student and not giving up on him/her in the attribution domain could also cue high ability feedback to that student.
2) **Giving out answer**: When a student gives the incorrect answer and the teacher him/herself provides the answer or calls out another student to provide the answer, this means that the teacher has low expectancy of that student and thus cues low ability feedback to that student. This can occur in two different ways that were coded for separately under this rubric:

   a) **Giving product answer**: where the teacher takes control of the situation and either solves the problem him/herself or just gives out the final answer to the student without giving the student any opportunity to contribute. For example, when a teacher grabs the pencil from the student and attempts at solving the whole problem that the student needs help with without involving the student, it is coded under this subcategory.

   b) **Giving process answer**: where the teacher explains or provides the process of arriving at the correct response but still leaves the student to come up with the final answer. For example, the teacher goes to a student who is having trouble with solving an addition of fractions problem and says, “Draw your candy bar first, then color in \( \frac{3}{4} \) of the first bar, now color in \( \frac{1}{4} \) of the second bar. Count the colored pieces. How many do you have altogether?”

**Recipient of feedback.** Under this rubric, I coded for individual(s) that the feedback was directed at. The recipient was coded as either a single female student, a single male student, group of students, or the whole class.
**Context of interaction.** The context of the interaction was coded as either public or private depending on where the interaction was happening. If the teacher interacted with a student privately without including any other student, this would be coded as private. If the interaction occurred in a group setting where more than one student was involved in the interaction with the teacher, this would be coded as group. And if the teacher directed his/her prompt at the whole class, even if the teacher interacted with only one or two students but publicly when the whole class was listening, then this would be coded as public.

**Outcome variable.** The outcome variable used in this study was students’ mathematics achievement gain scores. Before and after the five fractions lessons videotaped for each teacher and his/her classroom, students took a test on fractions. Therefore, for each teacher’s classroom we had a record of pre and post-tests of students’ performance in fractions. For the purpose of this study, we looked at the amount of gain students had after teachers teaching the topic of fraction by subtracting the class’s mean pre-test score from their mean post-test score. This mathematics achievement gain score was then used as the outcome variable in the multivariate modeling of how attributional feedback predicts student achievement.
Chapter 4: Results

Statistical Methodology

Inter-rater reliability. I applied this rubric to 55 videotaped classroom lessons, one lesson for each fifth grade teacher. Inter-rater reliability, which was estimated as percent agreement between each coder and a master created by the two individuals involved in the training for this rubric, was evaluated prior to coding, at midpoint, and at the endpoint of coding all videotapes. Percent agreement for identifying all types of feedback enumerated in the previous section was above 80% for both raters at the beginning of coding, midpoint, and endpoint indicating that coders applied the codes with a sufficient degree of consistency.

Multiple regression analysis. To assess the association between different types of attributional feedback and students’ achievement in mathematics, I have adopted a multiple regression statistical technique. Multiple regression analysis would be a suitable technique for this study because the data used for this study is videotaped data of real-world classrooms where variables are naturally correlated and intertwined with each other. Multiple regression is known to be a satisfactory technique for observational or survey research because it is flexible with regards to variables that are correlated in natural settings and that cannot be meaningfully reduced to orthogonal variables similar to laboratory setting designs (Tabachnick & Fidell, 2006). Multiple regression also has the advantage of its utility in the analysis of continuous in addition to dichotomous Independent variables.
Using the multiple regression analysis we can also arrive at a generalizable equation that best predicts our dependent variable from several independent variables. In this study, I examined the amount of variance in student achievement scores explained by attributional and strategy feedback in a single model applying a standard multiple regression analysis. I also examined the relative contribution of each type of feedback to the achievement scores separately using this technique. Multiple regression also provides the opportunity to evaluate the ability of the model to predict achievement scores after controlling for a number of additional variables that might be contributing to the variance in the dependent variable. Thus, I used hierarchical multiple regression analysis to control for the possible effect of teacher gender, feedback recipient, and context of feedback, to see if my set of independent variables (strategy and attributional feedback types) are still able to predict a significant amount of the variance in student achievement scores.

**Question 1: How frequently do teachers communicate each type of attributional feedback (direct vs. indirect) to students in natural classroom settings? Is there a significant difference between the two?**

**Descriptive statistics.** Table 2 displays how often fifth grade mathematics teachers in this sample communicated attributional feedback explicitly using ability, effort, and knowing-oriented statements and how often they did this through implicit behavior such as unsolicited offers of help, giving credit, abandoning, and calling out student names. In addition, other feedback types coded for this study (strategy feedback, tackling, and general feedback) are also included in this table. In order to be able to compare the two different types of attributional feedback (direct and indirect), I aggregated the different components coded as direct and indirect attributional feedback.
into blocks. The frequency of the two attributional feedback types are shown in Table 3 as blocks of direct and indirect attributional feedback.

Table 2

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th>Range</th>
<th>Min</th>
<th>Max</th>
<th>Sum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort-oriented feedback</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>53</td>
<td>.96</td>
<td>1.50</td>
</tr>
<tr>
<td>Ability-oriented feedback</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>75</td>
<td>1.36</td>
<td>2.34</td>
</tr>
<tr>
<td>Knowing-oriented feedback</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>44</td>
<td>.80</td>
<td>1.69</td>
</tr>
<tr>
<td>Unsolicited offer of help</td>
<td>47</td>
<td>0</td>
<td>47</td>
<td>770</td>
<td>14.00</td>
<td>10.50</td>
</tr>
<tr>
<td>Giving credit</td>
<td>16</td>
<td>0</td>
<td>16</td>
<td>203</td>
<td>3.69</td>
<td>3.50</td>
</tr>
<tr>
<td>Abandoning</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>164</td>
<td>2.98</td>
<td>4.25</td>
</tr>
<tr>
<td>Calling out student name</td>
<td>36</td>
<td>0</td>
<td>36</td>
<td>411</td>
<td>7.47</td>
<td>7.07</td>
</tr>
<tr>
<td>Calling out whole class</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>117</td>
<td>2.13</td>
<td>2.06</td>
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<tr>
<td>“Why” Strategy questions</td>
<td>22</td>
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<td>22</td>
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<td>5.42</td>
<td>4.81</td>
</tr>
<tr>
<td>“How” Strategy questions</td>
<td>19</td>
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<td>19</td>
<td>376</td>
<td>6.84</td>
<td>5.46</td>
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<tr>
<td>“What” &amp; other strategy questions</td>
<td>57</td>
<td>0</td>
<td>57</td>
<td>902</td>
<td>16.40</td>
<td>12.72</td>
</tr>
<tr>
<td>Strategy statements</td>
<td>31</td>
<td>0</td>
<td>31</td>
<td>364</td>
<td>6.62</td>
<td>7.56</td>
</tr>
<tr>
<td>Giving product type answers</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td>136</td>
<td>2.47</td>
<td>2.64</td>
</tr>
<tr>
<td>Giving process type answers</td>
<td>22</td>
<td>0</td>
<td>22</td>
<td>498</td>
<td>9.05</td>
<td>6.06</td>
</tr>
<tr>
<td>Giving both product &amp; process answers</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>39</td>
<td>.71</td>
<td>1.27</td>
</tr>
<tr>
<td>Tackling</td>
<td>43</td>
<td>1</td>
<td>44</td>
<td>794</td>
<td>14.44</td>
<td>8.94</td>
</tr>
<tr>
<td>General feedback</td>
<td>147</td>
<td>16</td>
<td>163</td>
<td>3439</td>
<td>62.53</td>
<td>30.56</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>Attributional Feedback Blocks</th>
<th>Range</th>
<th>Min</th>
<th>Max</th>
<th>Sum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Attributional FB</td>
<td>14.40</td>
<td>1.60</td>
<td>16.00</td>
<td>333.00</td>
<td>6.05</td>
<td>3.32</td>
</tr>
<tr>
<td>Direct Attributional FB</td>
<td>5.67</td>
<td>.00</td>
<td>5.67</td>
<td>57.33</td>
<td>1.04</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Note. The indirect attributional feedback block is an aggregate of the variables: unsolicited offers of help, Giving credit, Abandoning, calling out students’ names, calling out whole class. The direct attributional feedback block is an aggregate of the variables: Ability-oriented feedback, Effort-oriented feedback, and Knowing-oriented feedback.

**T-test.** In order to evaluate the difference between the number of times teachers communicated attributional feedback directly to students compared to doing this
indirectly through implicit behavior, I adopted a paired-samples t-test. This analysis indicated that teachers communicated attributional feedback through implicit behavior \( (M = 6.05, SD = 3.32) \) statistically significantly more times than through direct attributional statements \( (M = 1.04, SD = 1.18) \) with \( t(54) = -11.54, p < .001 \) (two-tailed; Figure 3). The mean difference was -5.01 with a 95% confidence interval ranging from -5.88 to -4.14. The eta squared statistic (.71) indicated a large effect size with a substantial difference in the two types of feedback communicated in classrooms.

Figure 3

*Difference between teacher’s direct compared to indirect attributional feedback in classrooms*
Question 2: How well does attributional feedback predict achievement in fifth grade mathematics classrooms? How much variance in achievement scores can be explained by each type of feedback?

**Standard multiple regression with grouped variables.** In order to explore the association between different attributional feedback types and students’ achievement scores, I used a standard multiple regression. This analysis involves all of the independent variables (attributional feedback types) being entered into one model at once. For this research question, because I solely wanted to examine the effect of attributional feedback (direct and indirect) on mathematics achievement scores, I only included the two attributional feedback types of direct and indirect as aggregated blocks displayed in the previous analysis as well as the tackling variable block (which is taken as a potential indication of attributional feedback) in this model. The results of this analysis will indicate how well attributional feedback is able to predict student mathematics achievement, and it will also tell us how much unique variance each of the independent variables (direct attributional feedback, indirect attributional feedback, and tackling) explains in the dependent variable over and above the other independent variables included in the model.

**Evaluating the model.** The results of the multiple regression indicated that this model, which included attributional feedback in blocks of indirect, direct, and tackling feedback, explained 14% of the variance in achievement scores (adjusted $R^2 = .139$, $F(3,55) = 3.900, p < .05$). I used the adjusted $R$ square statistic instead of $R$ square because adjusted $R$ square corrects this value to provide a better estimate of the true population value when a small sample size is involved.
Evaluating each of the independent variables. Next I evaluated each of the attributional feedback types and their contribution to the prediction of student mathematics achievement. As shown in table 4, the variable direct attributional feedback makes the strongest unique contribution to explaining achievement scores, when the variance explained by all other variables in the model is controlled for. This variable is making a statistically significant unique contribution to the prediction of achievement ($B = -.397, p < .005$). The Beta value for Tackling was slightly lower ($B = .239, p = .070$) and is not making a significant unique contribution to the prediction of student mathematics achievement. This may be due to overlap with the other independent variables in the model.

Table 4

*Multiple Regression Analysis predicting mathematics achievement from attributional feedback blocks*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variables</th>
<th>Standardized Beta</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement</td>
<td>Indirect Attributional FB</td>
<td>.145</td>
<td>1.095</td>
<td>.279</td>
</tr>
<tr>
<td></td>
<td>Direct Attributional FB</td>
<td>-.397</td>
<td>-3.009</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Tackling</td>
<td>.239</td>
<td>1.849</td>
<td>.070</td>
</tr>
</tbody>
</table>

Standard multiple regression with individual variables. In order to thoroughly examine how much each type of feedback within each of the attributional feedback blocks adopted above contributed to student mathematics achievement, I entered all the different types of feedback coded in mathematics classrooms individually in a second model predicting achievement scores.

Evaluating the model. The results of this analysis indicated that when all the various types of feedback are individually placed in one model – without being grouped –
they can explain 54% of the variance in achievement scores (adjusted $R^2 = .543$, $F (12, 55) = 6.347, p < .005$).

_Evaluating each of the independent variables._ When evaluating the extent that each feedback type individually contributed to the prediction of student mathematics achievement, as shown in Table 5, the variable “giving credit to students” makes the strongest unique contribution to explaining achievement scores ($B = .375, p < .005$), when the variance explained by all other variables in the model is controlled for. Tackling also makes a strong statistically significant unique contribution to explaining achievement scores ($B = .357, p < .005$). Moreover, the “calling out student names” variable ($B = .233, p < .05$) and the “ability-oriented feedback” variable ($B = -.221, p < .05$) make statistically significant contributions in this model although their associations with achievement are not as strong as the two previous variables (cf. Table 5).

Table 5

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variables</th>
<th>Standardized Beta</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsolicited help</td>
<td>.037</td>
<td>.333</td>
<td>.741</td>
<td></td>
</tr>
<tr>
<td>Giving credit</td>
<td>.375</td>
<td>3.409</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Abandoning</td>
<td>-.073</td>
<td>-.636</td>
<td>.528</td>
<td></td>
</tr>
<tr>
<td>Calling out student name</td>
<td>.233</td>
<td>2.025</td>
<td>.049</td>
<td></td>
</tr>
<tr>
<td>Effort-oriented FB</td>
<td>-.075</td>
<td>-.773</td>
<td>.444</td>
<td></td>
</tr>
<tr>
<td>Ability-oriented FB</td>
<td>-.221</td>
<td>-2.026</td>
<td>.049</td>
<td></td>
</tr>
<tr>
<td>Knowing-oriented FB</td>
<td>-.104</td>
<td>-.980</td>
<td>.333</td>
<td></td>
</tr>
<tr>
<td>Giving product type answer</td>
<td>-.162</td>
<td>-1.265</td>
<td>.213</td>
<td></td>
</tr>
<tr>
<td>Giving process type answer</td>
<td>.001</td>
<td>.007</td>
<td>.994</td>
<td></td>
</tr>
<tr>
<td>Giving both types of answers</td>
<td>-.016</td>
<td>-.113</td>
<td>.911</td>
<td></td>
</tr>
<tr>
<td>Tackling</td>
<td>.357</td>
<td>3.327</td>
<td>.002</td>
<td></td>
</tr>
</tbody>
</table>
Question 3: Does accompanying strategy feedback with attributional feedback better predict student achievement in fifth grade mathematics classrooms?

To assess how much of a contribution strategy feedback makes on the association between attributional feedback and student mathematics achievement, I included the variables coded as strategy feedback ("why", "how", "what" strategy questions, and strategy statements) in a model along with attributional feedback variables to predict student mathematics achievement. The variables included in this model are displayed in Table 6 where the strategy feedback variables are color coded in gray.

**Evaluating the model.** The results of this multiple regression analysis indicated that strategy feedback along with attributional feedback explained 57% of the variance in achievement scores (adjusted $R^2 = .568$, $F (16, 55) = 5.432, p < .005$), which is slightly higher than the contribution made by attributional feedback alone.

**Evaluating each of the independent variables.** With regards to the individual contribution of the variables in the model and the extent to which they explain the variance in achievement scores, as shown in Table 6, the predictor variables of "giving credit to students" ($B = .396, p < .005$) and "ability-oriented feedback" ($B = -.252, p < .05$) that portrayed a significant contribution in the previous model, still explain a significant amount of the variance of achievement with a slightly stronger contribution than when strategy feedback was not included in the model. Moreover, the "strategy statement" variable, which is one of the components, coded as strategy feedback also makes a statistically significant unique contribution to the prediction of achievement ($B = .302, p < .05$). On the other hand, the two variables "calling out student names" ($B =
.159, \( p = .180 \)) and “tackling” \( (B = .067, p = .735) \) that showed significant contribution to the prediction of achievement scores, did not hold their association in this model and do not indicate a unique significant contribution.

Table 6

*Multiple Regression Analysis predicting mathematics achievement from individual attributional feedback and strategy feedback variables*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variables</th>
<th>Standardized Beta</th>
<th>( t )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement</td>
<td>Unsolicited help</td>
<td>-.100</td>
<td>-.782</td>
<td>.439</td>
</tr>
<tr>
<td></td>
<td>Giving credit</td>
<td>.396</td>
<td>3.614</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Abandoning</td>
<td>-.038</td>
<td>-.329</td>
<td>.744</td>
</tr>
<tr>
<td></td>
<td>Calling out student name</td>
<td>.159</td>
<td>1.367</td>
<td>.180</td>
</tr>
<tr>
<td></td>
<td>Calling out whole class</td>
<td>.064</td>
<td>.633</td>
<td>.531</td>
</tr>
<tr>
<td></td>
<td>Effort-oriented FB</td>
<td>-.140</td>
<td>-1.401</td>
<td>.169</td>
</tr>
<tr>
<td></td>
<td>Ability-oriented FB</td>
<td>-.252</td>
<td>-2.323</td>
<td>.032</td>
</tr>
<tr>
<td></td>
<td>Knowing-oriented FB</td>
<td>-.016</td>
<td>-.140</td>
<td>.890</td>
</tr>
<tr>
<td></td>
<td>Giving product type answer</td>
<td>-.096</td>
<td>-.753</td>
<td>.456</td>
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<tr>
<td></td>
<td>Giving process type answer</td>
<td>.056</td>
<td>.479</td>
<td>.635</td>
</tr>
<tr>
<td></td>
<td>Giving both types of answers</td>
<td>.025</td>
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<td>.861</td>
</tr>
<tr>
<td></td>
<td>Tackling</td>
<td>.067</td>
<td>.342</td>
<td>.735</td>
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<tr>
<td></td>
<td>“Why” strategy questions</td>
<td>.055</td>
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<td>.672</td>
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<tr>
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<td>“How” strategy questions</td>
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<td></td>
<td>Strategy statements</td>
<td>.302</td>
<td>2.224</td>
<td>.032</td>
</tr>
</tbody>
</table>

Question 4: If we control for the possible effect of teacher’s gender, the recipient of feedback, and context of interaction, can attributional and strategy feedback still explain a significant amount of the variance in mathematics achievement scores?

**Hierarchical multiple regression.** Using hierarchical multiple regression analysis I evaluated the ability of the previous model (which includes all the attributional and strategy feedback variables) to predict student mathematics achievement scores, after controlling for a teacher gender, feedback recipient, and context of interaction. Using this
analysis I entered the variables in blocks in a predetermined order, with the first block forcing teacher gender, feedback recipient, and context of interaction into the analysis, and the second block entering the rest of the independent variables into the model. This way, the possible effect of teacher gender, feedback recipient, and context of interaction has been removed and thus we can see whether our block of independent variables are still able to explain some of the remaining variance in achievement scores.

**Evaluating the model.** After the variables in block 1 (covariates) have been entered (Table 7, Model 1), the overall model explains 7% of the variance (adjusted $R^2 = -.066$, $F (7, 55) = .523$, $p = .813$). After block 2 variables (attributional and strategy feedback) have also been added (Table 7, Model 2), the model as a whole explains 59% of the achievement variance (adjusted $R^2 = .594$, $F (23, 55) = 4.429$, $p < .005$). It is important to note that the second adjusted R square value reported here includes all the variables from both blocks, not just those included in the second step. Finally, the results of this analysis indicated that attributional and strategy feedback explained an additional 69% of the variance in student mathematics achievement, even when the effects of teacher gender, feedback recipient, and context of interaction were statistically controlled for ($R^2$ change = .694, $F (16, 31) = 5.767$, $p < .005$).

**Evaluating each of the independent variables.** Table 7, Model 2 summarizes the results, with all the variables entered into the equation predicting mathematics achievement. Model 2 results indicate that all three variables that showed significant contributions to the prediction of achievement scores when the possible covariates were not controlled for hold their strong association even with the covariates in the model. In order of their strength in explaining achievement score variance based on their Beta
values, “giving credit to students” uniquely explains 41% ($B = .410, p < .005$), “strategy statements” uniquely explains 39% ($B = .385, p < .05$), and “ability-oriented feedback” uniquely explains 32% ($B = -.315, p < .05$). Additionally, “effort-oriented feedback” also showed significant unique contribution to the prediction of mathematics achievement in this model ($B = -.243, p < .05$). Examining the covariates that we controlled for in this model, neither teacher gender, recipient of feedback, nor context of interaction made a unique contribution in this model (for beta values of each variable please refer to Table 7).

Table 7

Hierarchical Multiple Regression Analysis predicting mathematics achievement from attributional and strategy feedback when controlling for possible covariates

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variables</th>
<th>Standardized Beta</th>
<th>t</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Achievement</td>
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<td>Teacher gender</td>
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<td>Female student recipient</td>
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<td>Class recipient</td>
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<td>Group recipient</td>
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<td>Time in public interaction</td>
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<td>Time in private interaction</td>
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<td>Model 2</td>
<td>Achievement</td>
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<td>Unsolicited help</td>
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<td>Giving credit</td>
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Chapter 5: Discussion

This study explored the role of attributional feedback made by teachers on students’ mathematics achievement in natural classroom settings by addressing four overarching aims: (1) To examine if attributional feedback occurs in natural classroom settings and if they do, how are they mainly communicated to students; (2) To establish how well attributional feedback can predict student achievement in mathematics; (3) To explore if attributional feedback would have a stronger association with student mathematics achievement if strategy feedback accompanied it; and (4) To assess the strength of attributional feedback’s contribution to student mathematics achievement even when the possible effect of teacher gender, feedback recipient, and context of interaction is removed. I captured all the different types of feedback through observationally coding videotaped data of fifth grade mathematics classrooms and examined each aim using multiple regression modeling.

Summary of Results

Is attributional feedback really rare in natural classroom settings? Despite what Foote (1999) had found in her study of examining explicit attributional statements stated by teachers in classrooms, the results of this study indicated that teachers do in fact use attributional feedback often in natural classroom settings. The reason why Foote (1999) was not able to identify much of the attributional messages directed to students could be that Foote’s (1999) examination of attributional feedback was only through coding for explicit predefined attributional statements that teachers verbalized in classrooms. If we expand this exploration into different ways that attribution can be
communicated in classrooms, more evidence of these types of feedback will be revealed. As in the current study, when I expanded my search for attributional feedback in teachers’ behavior that implicitly conveyed attributional messages to students in addition to the explicit standard attributional statements, a significant number of such feedback was observed in classrooms. Interestingly, the number of times attribution was communicated implicitly through teachers’ behavior occurred significantly more often than through explicit attributional statements (Figure 3).

**Does attributional feedback make a difference in student mathematics achievement?** Combining all the different indicators of attributional feedback coded in this study into three groups of direct, indirect, and tackling, and placing them in a single model to predict student mathematics achievement, overall, I found that attributional feedback does indeed contribute significantly to student mathematics achievement. Examining the components contributing to this effect individually, out of the three types of attributional feedback defined, only direct attributional feedback showed a unique significant contribution to student mathematics achievement scores. Interestingly, the results showed that direct attributional feedback’s contribution to mathematics achievement is negative, meaning that with more direct attributional feedback, student mathematics achievement score decreases. On the other hand, indirect attributional feedback’s contribution to mathematics achievement is positive. This shows that conveying attributional feedback indirectly to students is helpful to students but direct attributional feedback might even harm student mathematics achievement.
When the components of these three groups of attributional feedback were entered into a model individually to predict student mathematics achievement, the results revealed that at least one variable from each of the direct attributional feedback, indirect attributional feedback, and tackling feedback groups defined previously were uniquely contributing to the prediction of mathematics achievement scores. From the direct attributional feedback group, “ability-oriented feedback” showed a significant negative effect on student mathematics achievement. From the indirect attributional feedback group, giving credit to students and calling out student names both indicated a significant positive effect on student mathematics achievement. And finally from the tackling group, the act of tackling (giving opportunities to students to come up with an answer) also showed a significant positive effect on student mathematics achievement. Overall, the results indicate that all the three types of attributional feedback (direct, indirect, and tackling) are contributing to the prediction of mathematics achievement scores and at least one variable in each feedback type is dominant in this contribution.

Moreover, despite the fact that previous research has claimed that students respond differently to effort and ability-oriented feedback depending on the stage of learning, the results of this study show otherwise. The direction of the coefficients for “effort-oriented feedback” and “ability-oriented feedback” are both negative in this model indicating that an increase in both types of feedback predicts a decrease in mathematics achievement. On the other hand, if we direct our attention to the indirect attributional feedback variables such as “giving credit” which is an indirect ability-oriented feedback, it shows a positive association with mathematics achievement. From this we can conclude that, based on the current results, attributional feedback is only
beneficial for student mathematics achievement when it is communicated indirectly to students, no matter if it’s ability or effort-oriented.

**What role does strategy feedback play in the contribution of attributional feedback on student mathematics achievement?** When I added the components that were defined as strategy feedback into a model with the rest of the attributional feedback variables, not only the strong effect of attributional feedback on mathematics achievement still held, the results also showed a slight increase in the strength of the effect. This indicates that attributional and strategy feedback together do make a more effective contribution to students’ mathematics achievement in mathematics than attributional feedback alone. Examining this effect in the individual level, again we can see that the “giving credit to students” and “ability-oriented feedback” still hold a strong significant positive effect on student mathematics achievement. In addition, the “strategy statements” variable, which is an indicator of strategy feedback, also showed a significant positive effect on student mathematics achievement.

On the other hand, the two variables “calling out students’ name” and “tackling”, which displayed significant contributions, when strategy feedback was not included in the model did not show unique significant associations with student mathematics achievement anymore. These distortions in the observed associations could be due to some confounding effects and multicollinearity. Exploring this further, I looked at the correlations between the independent variables present in this model and found a high bivariate correlation (R= .742) between “tackling” and “what strategy questions” which indicates collinearity. This explains why when the variable “what strategy questions” is
entered into the model, due to the overlap that these two variables have, the “tackling” variable loses its unique contribution to student mathematics achievement. This overlaying of these two variables is understandable since the variable “tackling” is when teachers rephrase, repeat questions, or ask additional questions to provide opportunities for students to figure out the solution to a problem. These questioning routines, more or less, contain many “what strategy questions” which explains the overlap and correlations indicated in this analysis.

However, no high bivariate correlation was seen between the “calling out students’ name” variable and other independent variables in the model. To determine why there was a distortion in “calling out students’ name” variable’s association in the model I searched for a confounding effect by one of the variables from the strategy feedback group. Confounding is defined as the masking of a significant effect of an independent variable on the desired outcome through the presence of another independent variable. To identify the independent variable that was creating this confounding effect, I compared the results from regression models, with and without each of the strategy feedback variables (strategy statements, “what”, “why”, and “how” strategy questions) that were initially added in this model and examined how the coefficient from the “calling out students’ name” variable changed. The results showed that only when the strategy statement variable was eliminated from the model, the “calling out students’ name” variable’s effect became stronger again and approached significance. This suggests that the “strategy statements” variable is masking “calling out students’ name” variable’s effect.
Does teacher gender, recipient of feedback, and context of interaction matter when attributional feedback is communicated to students? Because we are examining teacher feedback in natural classroom settings, we need to keep in mind that other factors could be present in the classroom environment that can affect the contribution that attributional feedback makes on student mathematics achievement. In a classroom, teachers may show different patterns of behavior depending on their gender, which could influence their interactions with students and in turn impact student mathematics achievement. In addition, research has shown that depending on teacher gender, the recipient of teacher feedback (Duffy, Warren, & Walsh, 2001) and also teacher’s assessment of students’ competence could vary (Hopf & Hatzichristou, 1999). At the same time, male students have shown to initiate more direct verbal interactions with teachers than female students (Duffy et al., 2001) so student gender could also be a contributing factor on the association between teacher feedback and student mathematics achievement. Additionally, student mathematics achievement gains have also been shown to vary depending on the instructional setting (i.e., individual, small group, whole class teacher-student interactions; Brophy & Evertson, 1978). Therefore, because this study has been conducted in a natural classroom environment and not an isolated laboratory, and that we want to assess the contribution of attributional feedback on student mathematics achievement in a natural context, it is important to consider the factors that might play a role in this association.

Results from this analysis indicated that after controlling for the effect of teacher gender, recipient of feedback, and interaction context, attributional feedback accompanied by strategy feedback still strongly predicted student mathematics
achievement. Going over the unique contribution of the variables involved in this model after controlling for the contextual factors, the three variables of “giving credit to students”, “ability-oriented feedback”, and “strategy statements” that showed significant effects in the previous model, were still strongly associated with student mathematics achievement. Interestingly, when having the contextual covariates in the model, the “effort-oriented feedback” variable also displayed a unique significant contribution to student mathematics achievement. This could be due to a suppressor effect in the model.Suppressor is an independent variable which when added to the model strengthens the effect of another independent variable on the dependent variable. This raises the observed R square because of its accounting for the residuals in the model and not because of its own association with the dependent variable. The increase in R square when adding an independent variable is the square part correlation of that independent variable in the new model. Thus, in order to identify the independent variable that is acting as the suppressor in this model, I compared the part correlation of the covariates that I had added to the model with their zero-order $r$ and realized that the covariates “teacher gender” and “student gender” have greater part correlation than zero-order $r$ and therefore are acting suppressors for “effort-oriented” feedback. So teacher and student gender mostly suppress the error of the reduced model. While they are weak predictors themselves, they suppress error components for “effort-oriented feedback” and thus lend considerable facilitating aid by raising its regression coefficient.

**Theoretical Implications**

Theoretically it has been argued that attributional feedback, especially in educational settings, plays an important role in achievement and more broadly in
developing dispositions. In the past decades there has been some attempts at experimentally examining attributional feedback in isolated laboratory contexts that found statements referring to students’ ability and effort at the time of success or failure is associated with student motivation and achievement (Bryan, Bryan, & Dohrn, 1993; Yasutake, Bryan, & Dohrn, 1996; Schunk, 1983, 1984, 1989, 2003). However, empirical literature in natural environments, particularly in educational settings, supporting this theoretical idea is lacking. Thus, this study attempted to examine the effect of attributional feedback by the teacher on students’ mathematics achievement in natural classroom setting.

**Attributional feedback through attribution theory.** Based on attribution theory (Weiner, 1979; 1986; 2000), two types of causal attributions occur in the classroom at the time of a students’ success or failure. One is a from the students’ perspective about him/herself (intrapersonal) and the other is from the teacher’s perspective about the student (interpersonal). Because both of these causal attributions are made about a single event that has occurred for a specific student in a classroom, I proposed that both of these causal attributions would naturally be informing each other to lead to a specific outcome by the student and therefore are interrelated (cf. Figure 1). For example, in a classroom setting, at the time of a student’s failure in a task, both the student and the teacher start searching for causes of that event and then they start behaving accordingly. At this time, the teacher’s reaction to the event becomes one of the antecedents for the student’s causal ascriptions to his failure and thus begins feeling and acting based on the information he receives and the conclusion he makes about why he has failed. This contributes to the
amount of effort that the student puts in this task in the future, which consequently affects his/her achievement in that task.

The results from the current study partly confirmed this interrelationship of interpersonal and intrapersonal attribution in the classroom contexts by first of all showing that teachers make causal inferences about students based on the outcome of their performance and they do communicate those causal inferences through direct and indirect attributional feedback to students in classrooms, despite the previous literature (Foote, 1999) claiming that such feedback are rare. Secondly, this study confirmed this interrelationship by demonstrating that teacher's attributional feedback strongly predicts student mathematics achievement even when other factors in the classroom (teacher gender, student gender, and context of feedback) are controlled for. Although this study did not examine students’ causal attributions, we can infer by these results that teacher’s causal explanations about student outcome which is communicated through their verbal and behavioral feedback to students, affects students’ own causal ascriptions about their outcome, which in turn influences their future effort in the specific task and consequently affect their future achievement. Future studies are necessary to be certain about the role of students’ causal explanation in this interrelationship of teacher and student causal attributions.

**Attributional feedback in disposition development.** Theoretically, attributional feedback has also been argued to play a role in the way individuals develop habits and tendencies, specifically towards learning through the Disposition Development Model (Heshmati, 2011). In this model, the Disposition Formation phase explains that in order for an individual to meet demands, needs, and goals they act based on the differential
opportunities, validations and feedback, and challenges that receive in the society and consequently gain experience based on their actions. With more experience, predictions are made, and with more predictions, expectations develop. When this cycle of action, experience, prediction, and expectation recur dispositions and habits start forming in individuals. At times, when this cycle is broken and expectations are left unmet, individuals come out of this cycle and start looking for causes in their environment and themselves in a way as to maintain a positive self-image and hence, begin their attributional search.

In this phase of disposition formation, theory suggests that feedback and validation play an important role whether outcome of actions occur as expected or not. Specifically, in an educational context, teacher’s feedback could make a big difference both when students are striving to achieve in a task and base their actions towards that goal on the opportunities, challenges and the validation and feedback that teachers provide them, and when the outcome of their actions don’t turn out as expected and they search for causes in the feedback teachers convey to them. The results of the current study again validate this claim empirically. The findings from this study confirm the Disposition Development Model in that when teachers provide students with effective feedback (attributional and strategy feedback) they direct students towards acting in a certain way to achieve in the specific task. Once students adopt these strategies using the information conveyed by teachers – who are the main influencers in an educational context – and repeatedly achieve using those strategies, these actions become habits and dispositions for that student which leads to future achievement, hence the strong
association between attributional and strategy feedback with student mathematics achievement.

**Combination of attributional and strategy feedback.** Previous research and theory has suggested that when feedback in general (Hattie & Timperley, 2007), and attributional feedback specifically (Dohrn & Bryan, 1994), is combined with strategy feedback it leads to better achievement gains for students. This is because students are provided with information about the task and strategies about how to do the task to work on the task more effectively and consequently persist longer and acquire adaptive attributions. Although experimental studies have provided evidence for this effect, two points still remain unclear. First, do strategy and attributional feedback occur together in natural classroom settings? And second, if they do occur, how can attributional messages and strategy feedback be conveyed to students so that they have the strongest effect on students’ achievement?

The current study addressed both of these points. Data revealed that attributional and strategy feedback do occur in natural classroom settings though not in the traditional way that might be used in experimental studies. Attributional messages in classrooms are mostly communicated to students in an indirect way, through teacher’s implicit behavior like offering unsolicited feedback, giving credit to students for correct responses, and abandoning a student when they don’t know the response to a question. However, teachers still do use the traditional direct attributional statements in their feedback in classrooms, though rarely. Strategy feedback also occurs in classrooms either through questions that might direct students to the correct strategy for tackling a problem or providing statements that point to potential strategies for the task at hand.
Assessing the most effective way to provide attributional and strategy feedback to students, results of this study indicated that teachers who convey attributional messages in an indirect way, especially giving credit to students when they come up with a correct response to problems, and combine it with statements that provide particular task strategies will contribute the most to student mathematics achievement through their feedback.

**Study Limitations and Future Directions**

Although this study attempted at examining most of the components that contribute to the association between attributional feedback and student mathematics achievement in classrooms, due to the limitation of the observational data used for this study, some factors still remain unexplored. For example, I was not able to capture the types of attributional messages conveyed by peers in classrooms, which could have a major impact on how students perceive themselves and the causes they attribute to their outcomes. The reason why these student-to-student interactions were not captured for this study was because the camera was only directed to be focused on the teacher and the teacher’s interactions with students, thus following the teacher at all times and not capturing all the student-to-student interactions that occurred when the teacher was not around. Therefore, it would be also beneficial to examine peer’s attributional messages conveyed to students and explore its effect on student achievement in future studies.

In addition, despite the fact that we can imply from the results of this study that the types of attributional feedback captured here affect student mathematics achievement through influencing students’ own causal ascriptions to their outcome, but there is no concrete evidence to prove this claim. Thus, it would be necessary to conduct future
studies on the direct link between teachers’ attributional feedback and students’ own
causal ascriptions and consequently student’s achievement in the specific task in order to
become certain about this causal link.

Finally, this study only examined how teachers’ attributional feedback influenced
student achievement. Teachers’ attributional feedback could have other impacts on
students’ perceptions of themselves, their motivation, and also their persistence in the
specific task. Ergo, future studies could focus on other aspect of student well-being in
natural classroom settings and explore how teachers’ attributional feedback impacts
student’s educational motivation.

Conclusion

This study explored various forms of attributional feedback that teachers
communicate to students in natural classroom settings through observational video data
analysis in order to better understand the effects of attribution on mathematics
achievement in complex environments such as classrooms. The results of this study
highlighted the presence of attributional feedback in teacher-student interactions and its
significant role in student mathematics achievement. Overall, data presented for this
study indicated that for teachers to be most effective in their feedback to students, first it
is necessary that they communicate attributional feedback in an implicit and indirect way
through behavioral cues, and second, they combine attributional feedback with strategy
feedback that consists of statements providing strategies to best tackle the task at hand.
Moreover, the results showed that it does not matter if the attributional feedback is ability
or effort oriented as long as it is conveyed indirectly. One indirect attributional feedback
type that showed a strong association with student mathematics achievement no matter
what it was accompanied by was giving credit to students when they provided a correct solution to a problem. Thus, it would be beneficial to incorporate this behavior in instructional feedback in classrooms. Overall, this study attempted at portraying a thorough and complete picture of the attributional environment in complex classroom settings in hopes of assisting teachers in establishing a climate that promotes motivation and enhances student learning.
References


