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A Mixed Methods Study of the Relationship between Student Perceptions of Teacher-Student Interactions and Motivation in Middle Level Science

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Abstract

This mixed-methods study examined the relationship between middle level science students' perceptions of teacher-student interactions and students’ science motivation, particulary their efficacy, value, and goal orientation for learning science. In this sequential explanatory design, quantitative and qualitative data were collected in two phases, with quantitative data in the first phase informing the selection of participants for the qualitative phase that followed. Results from phase one indicated that students’ perceptions of teacher interpersonal behaviors were positively correlated with their efficacy for learning science, value for learning science, and mastery orientation. Results from phase two revealed themes related to students’ construction of their perceptions of teacher interpersonal behavior and dimensions of their efficacy and task value for science. Theoretical implications, implications for educational practice, and future research directions are also discussed.

Keywords: classroom research, middle schools, motivation, science education, teacher-student interactions

Teacher-student interactions have the potential to affect students on many levels, including achievement, motivation, and adjustment to school (den Brok, Levy, Brekelmans, & Wubbels, 2005; Pianta, 1999; van den Oord & Van Rossem, 2002). Research on teacher-student interactions in early childhood, elementary, and secondary settings has shown that some types of classroom interactions can have a positive effect on various outcomes, including students’ academic development, achievement, and attitudes toward learning (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; O’Conner & McCartney, 2007; Pianta, 1999; Pianta & Nimetz, 1991). In addition, these teacher-student interactions can be predictive of student achievement and motivation as early as the elementary years (Pianta & Nimetz, 1991) and potentially continuing into the middle grades (den Brok et al., 2005; O’Conner & McCartney, 2007). The purpose of the current study was to examine the relationship between middle level science students' perceptions of teacher-student interactions and students’ science motivation, particulary their value, goal orientation, and efficacy for learning science.

Teacher-Student Interactions

Defining the characteristics of high quality teacher-student interactions is critical to examining their impact on student outcomes. Gardiner & Kosmitzki (2008) defined high quality teacher-student interactions as consistent, stable, respectful, and fair interactions that facilitate the students' view of their teacher as a secure base. Students who view their teacher as a secure base are more likely to engage in help-seeking behaviors that, in turn, positively correlate with student achievement. High quality teacher-student interactions can also be typified by rich communication in instructional exchanges between the teacher and student (Cabell, DeCoster, LoCasale-Crouch, Hamre, & Pianta, 2013; Pianta, 1999). Open communication between the teacher and students can enable students to engage more deeply with content through classroom discourse and seek teacher assistance more confidently. Perceived emotional support is also a characteristic of high-quality interactions and has links with increased student achievement and academic motivation (Pianta, La Paro, Payne, Cox, & Bradley, 2002).

Drawing from Bronfenbrenner's Ecological Model (Bronfenbrenner, 1977), Pianta and Walsh (1996) developed the Contextual Systems Model (CSM) for analyzing children's experiences in school. The CSM provides a framework to view teacher-student relationships as situated within the broader context of classroom interactions. This framework posits that the following four main systems interact to influence the development of the child: the individual child, the family, the classroom, and the culture. Within the classroom level of the CSM, research indicates that teacher-student interactions are influential in student outcomes in science (den Brok et al., 2005). Specifically, students' perceptions of interactions with their teachers are highly correlated with students' attitudes towards science (Brekelmans, Wubbels, & van Tartwijk, 2005; den Brok, Fisher, Rickards & Bull, 2006; Fraser, 1991).

Research on teacher-student interactions in science has focused primarily on secondary science students and on students' *general* attitudes toward science. The present study seeks to extend this research to middle level science education and focuses specifically on students' domain-specific motivation for learning science. Thus, it extends the current research on teacher-student interactions to examine the constructs of task value, self-efficacy, and goal orientation.

Domain-Specific Motivation

The present study focuses specifically on science motivation as defined by the theories of goal orientation (Ames, 1992; Pajares, Britner, & Valiante, 2000), expectancy-value (Eccles & Wigfield, 2002; Eccles & Wigfield, 1994; Wigfield, 1994), and self-efficacy (Bandura, 1977, 1997). Students as young as eight years have demonstrated the ability to differentiate between subject areas in relation to motivational constructs (Anderman, 2003). Subject-specific motivation represents the values, attitudes, and conceptions that a student holds toward a specific academic domain (den Brok et al., 2005). Studies indicate that motivation can differ from one subject to another, especially during early adolescence (Stodolsky & Grossman, 1995; Wolters, 2004). As students move to the middle grades, where subject areas are more departmentalized and integration of subjects is less common than in elementary grades, motivational constructs may differ by domain.

Goal Orientation

Goal orientation refers to students' achievement goals, or the reasons students have for doing their academic work (Pajares et al., 2000). These achievement goals are typically described as either performance goal orientations or mastery goal orientations (Ames, 1992; Anderman & Patrick, 2012; Pintrich & Schunk, 2002). A performance orientation is typified by a focus on competition, comparison to others, and either displaying competence (performance-approach) or avoiding failure (performance-avoid) (Anderman & Patrick, 2012; Anderman, Patrick, & Ryan, 2004; Midgley, Kaplan, & Middleton, 2001; Murayama, Elliot, & Yamagata, 2011). In contrast, a mastery orientation is characterized by a focus on personal progress, improvement, and learning for learning's sake. Performance oriented students are more likely to make social comparisons and place value on doing better than other students (Pajares, et al., 2000; Schunk, 1996). Mastery oriented students tend to seek challenges and concern themselves with setting and achieving personal goals (Pajares et al, 2000; Anderman & Young, 1994). Mastery oriented students tend to make external attributions for failure, persist in the face of academic challenges, and employ more effective cognitive strategies than performance oriented students (Schunk, 1996; Anderman & Young, 1994). Conversely, performance oriented students tend to make internal attributions for academic failures, lack persistence in academic challenges, and employ less effective cognitive strategies than mastery oriented students (Anderman & Young, 1994; Murayama, Elliot, & Yamagata, 2011; Ryan & Patrick, 2001).

Aspects of the classroom learning environment are also influential in students' individual goal orientations (Anderman & Patrick, 2012; Church, Elliott, & Gamble, 2001; Midgley, Anderman, & Hicks, 1995). Teachers who promote competition and place a high value on test grades may foster the development of performance goal orientations in their students. Conversely, teachers who value understanding of concepts and emphasize individual effort over grades are more likely to encourage the development of mastery goal orientations in their students (Ames & Archer, 1988; Wolters, 2004). Evaluation practices are especially influential in goal orientations (Ames, 1992; Anderman & Midgley, 1998). As students move into the middle grades and high school, an increased emphasis is placed on normative evaluation, which encourages students to view their performance in comparison to the performances of other students. These normative evaluation practices work to foster performance-oriented goals structures within classes and, ultimately, in students (Ames, 1992).

Expectancy-value Theory

Expectancy-value theory posits that motivation is a function of an individual's expectancy for success for a given task and the individual's value for the task (Eccles & Wigfield, 1994; Eccles & Wigfield, 2002). Within this model, expectancies for success and task value are the two primary constructs related to an individual's motivation. Interestingly, these constructs have been studied together and in isolation. Research indicates that task value is often predictive of an individual's choices or decisions, while expectancies for success are more predictive of performance (Eccles & Roeser, 2011; Wigfield & Eccles, 2002).

A students' expectancies for success and his/her value for the domain or task can affect motivation (Bandura, 1997). Task value is central to the expectancy-value motivational theory (Eccles & Wigfield, 1994). Task value is generally discussed in terms of utility value, intrinsic value, attainment value, and cost (Wigfield & Eccles, 1992, 2002). Studies indicate that intrinsic and utility task value are predictive of students' effort in science classes and course selection (Cole, Bergin, & Whittaker, 2006; Wigfield, 1994).

Self-efficacy

Self-efficacy is a central concept to the development of students' academic motivation (Bandura, 1989; Bandura, Barbaranelli, & Caprara, 2001). Students with high self-efficacy for a task have confidence in their ability to perform the task effectively. In contrast, low self-efficacy is marked by a lack of confidence in one's abilities to succeed at a given task or domain (Pintrich, 2000; Pintrich & Schunk, 2002). Studies indicate that self-efficacy is positively correlated with student achievement (DiPerna & Elliott, 1999; DiPerna, Volpe, & Elliott, 2005; Whang & Hancock, 1994). Students who believe they can perform well in a specific academic domain make healthier attributions for both success and failure, consequently supporting learning strategies that are associated with higher student achievement (Weiner, 1985). Because self-efficacy has been identified as a domain-specific construct (Ormrod, 2006; Stipek, 1988), students may have higher self-efficacy for some academic tasks and lower self-efficacy in other areas.

Studies have also found that students' science self-efficacy is correlated with science achievement (Britner & Pajares, 2001; Pajares et al., 2000). In fact, Bandura (1997) postulated that students' self-efficacy for a domain may be a better predictor for their achievement in that specific content area than objective assessments. Students who are efficacious about their ability to learn science are more likely to attempt challenging tasks, persist at those tasks, and make positive attributions for both success and failure (Bandura, 1989, 1997). The opposite is true of students with low self-efficacy for learning science.

Motivation in the Middle Grades

Because motivation and achievement can be highly correlated (DiPerna & Elliott, 1999; DiPerna et al., 2005; Whang & Hancock, 1994), it is critical that students maintain an optimal level of motivation. However, research indicates that many students display a downward motivational shift in the middle grades, especially in the area of science (Anderman, Maehr, & Midgley, 1999; Eccles & Midgley, 1989). Motivational patterns in the middle grades often remain stable into high school and beyond, thereby influencing students' selection of courses in school and, ultimately, affecting their career trajectories (Eccles & Midgley, 1989).

The middle grades can be a challenging time for students because of a variety of developmental and social factors. Many students experience changes in cognitive and motivational factors during the middle grades (Duchesne, Ratelle, & Roy, 2012; Pajares et al., 2000; Rudolph, Lambert, Clark & Kurlakowsky, 2001; Singh, Granville, & Dika, 2002). In the middle grades, the school and classroom climate is often dramatically different than what it was during elementary school (Anderman, Patrick, & Ryan, 2004; Midgley, Anderman, & Hicks, 1995). Middle level students generally experience larger class sizes, multiple teachers, increased ability grouping, decreased parental involvement, and larger school buildings (Eccles & Wigfield, 1994). In addition, middle level teachers often exhibit more controlling behaviors within the classroom context, providing students with fewer choices and decreased opportunities to participate in decision-making processes within the classroom (Duchesne et al., 2012; Eccles & Midgley, 1989; Rudolph et al., 2001). Ironically, this shift in classroom control structures occurs at the developmental stage of early adolescence, a time when individuals have an increased need for autonomy (Eccles & Midgley, 1989).

In addition to changes in school and classroom climate, teacher factors are also different in the middle grades. Studies indicate that middle level teachers tend to exhibit less nurturing behaviors than elementary teachers (Barber & Olsen, 2004; Eccles & Midgley, 1989). With increased class sizes, middle level students may also perceive teacher-student relationships to be less personal and more distant, leading students to perceive less support from their teachers (Barber & Olsen, 2004).

Students may be especially likely to experience a decrease in their science motivation during the middle grades (Pajares et al., 2000; Singh, et al., 2002), exhibiting a subsequent drop in achievement. This decline in motivation and achievement is critical, as students' performance and attitudes in the middle grades influence their academic trajectories, high school course selections, and, ultimately, career choices (Anderman & Young, 1994; Singh et al., 2002). Motivational patterns in early adolescence are fairly stable and persist into high school and beyond (Eccles & Midgley, 1989). Because attitudinal factors and achievement in the middle grades have lingering effects, this drop in motivation during the middle grades in the area of science is a significant cause for concern. Several hypotheses exist to explain, at least in part, this drop in motivation, including developmental factors, peer factors, school characteristics, and parental involvement (Ryan & Patrick, 2001). However, many of these factors may be outside the realm of teachers' control and influence. The current study explores the role of teacher behaviors in students' motivation for learning science in the middle grades.

The Present Study

The purpose of this study was to examine the relationship between middle level science students' perceptions of teacher-student interactions and students' science motivation, particularly their goal orientation, efficacy, and valuing of science. This study follows a sequential explanatory mixed methods design and consists of a quantitative phase and a qualitative phase (Cresswell & Plano Clark, 2007). Specifically, the study follows a participant selection model in which quantitative data from the first phase were used to select participants for the second qualitative phase of the study. The following research questions guided the study:

- (Quantitative phase) What is the relationship between middle level science students' perceptions of teacher-student interactions and their motivation for learning science?
- (Qualitative phase) How do middle level science students construct perceptions of teacher-student interactions, and how do these perceptions affect their science motivation?

Based on the literature, we formulated the following hypothesis: Cooperative teacher interactions will be positively correlated with science motivation (goal orientation, value and efficacy for learning science). Conversely, we hypothesized that oppositional teacher interactions will be negatively correlated with science motivation.

Study Design

This mixed methods study employed a sequential explanatory model (Cresswell & Plano-Clark, 2007). The basis of the design was a participant selection model in which quantitative and qualitative data are collected in two phases—quantitative data in the first phase informs the selection of participants for the second qualitative phase. The second qualitative phase helps to clarify and explain results from the first quantitative phase. In this design, data mixing occurs between phase one and phase two (participant selection) and at the interpretation level (explanatory) after quantitative and qualitative data are analyzed separately. Figure 1 present a visual schematic for the design of this study.

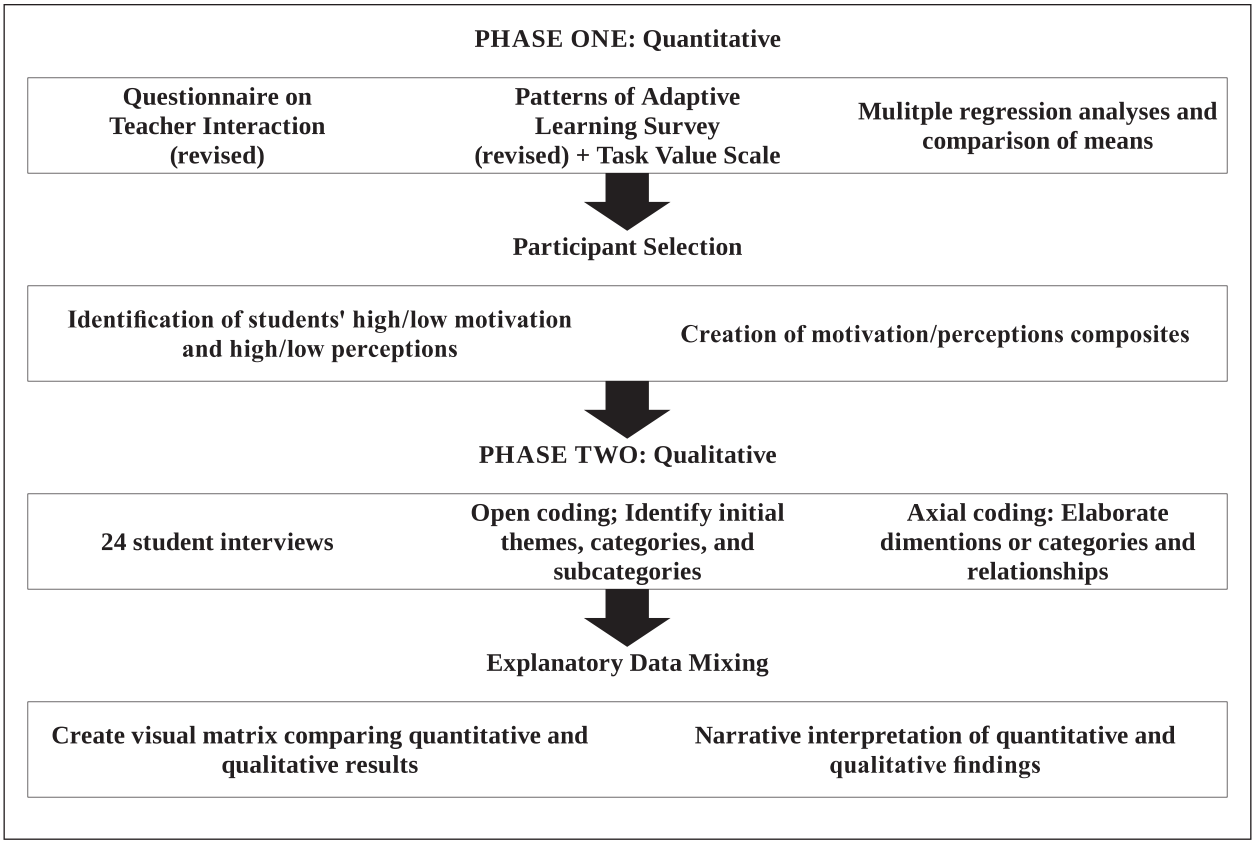

Figure 1. Sequential explanatory mixed methods design

Quantitative Phase: Method

Participants

Participants for this study were 223 sixth grade science students from a middle school in a school district in the southeastern United States. This middle school, situated in the suburbs of a metropolitan area, had a student enrollment of 1,069 with 34.7% of the students eligible for free and reduced meal status. The participants were the students of three science teachers and were members of 12 sixth-grade science classes in the school. Table 1 provides demographic information about the participants.

Outcome Measures

Questionnaire on Teacher Interaction. Student perceptions of interactions with their teachers were measured with the Questionnaire on Teacher Interaction (QTI) (Wubbels & Brekelmans, 2005). The QTI assesses students' perceptions of teacher-student interactions and includes items that describe students' interactions with teachers on a variety of dimensions. It is based on a theoretical model of proximity (cooperation vs. opposition) and influence (dominance vs. submission) (Leary, 1957). The 48 items of the QTI are organized into the following eight scales: Leadership, Helpful/Friendly, Understanding, Student Freedom, Uncertain, Dissatisfied, Admonishing, and Strict.

Patterns of Adaptive Learning Survey. The Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 2000) is based on goal orientation theory and was designed to measure relationships between the learning environment and dimensions of student motivation and affect. In its entirety,

Table 1
Demographics for Survey Participants (N=223)

Gender: Female	Gender: Male	Ethnicity: African American	Ethnicity: Caucasian	Ethnicity: Hispanic	Ethnicity: Asian American	Ethnicity: Other
112	111	64	126	14	12	7

Table 2
Descriptive Statistics

Variable	Mean	Standard Deviation	Variance	Range	Minimum	Maximum
Mastery Orien.	14.64	2.50	6.25	15.00	3.00	18.00
Perform. Orien.	23.38	6.79	46.11	30.00	6.00	36.00
Efficacy	13.51	2.53	6.41	13.00	5.00	18.00
Task Value	14.58	2.99	8.95	15.00	3.00	18.00
Leadership	11.92	11.92	5.56	12.00	3.00	15.00
Helping/Friendly	11.84	3.03	9.16	12.00	3.00	15.00
Understanding	11.44	3.05	9.30	12.00	3.00	15.00
Student Freedom	5.28	1.76	3.09	10.00	3.00	13.00
Strict	8.40	2.86	8.16	12.00	3.00	15.00
Admonishing	9.60	2.73	7.43	11.00	4.00	15.00
Dissatisfied	5.70	2.97	8.84	12.00	3.00	15.00

the measure includes both student scales and teacher scales. The student instrument includes the following sub-scales: (1) personal achievement goal orientations; (2) perceptions of teacher's goals; (3) perceptions of the classroom goal structure; (4) achievement-related beliefs, attitudes, and strategies, and (5) perceptions of parents and home life (Midgley et al., 2000). The PALS student instrument is based on a 5-point Likert scale ranging from 1 (not true at all) to 5 (very true).

Task value scale. A 3-item measure of task value, based on the dimensions of utility and importance of science, was also developed for this study. This scale was developed based on literature related to expectancy-value, of which task value is a central construct (Eccles & Wigfield, 1994, 2002). This scale was developed in conjunction with a measurement expert and educational psychologist familiar with the theoretical construct of task value. Readability for the task value scale was assessed using the Flesch-Kincaid Grade Level test and was determined to be 3.4 (third grade, four months). A motivational expert examined the task value scale for face validity. This task value scale was also piloted with a class of sixth-grade science students (N=25). Cronbach's Alpha for this pilot was 0.85, and an examination of "Cronbach's Alpha if Item Deleted" suggested that all items within these scales should be retained.

Procedure

Student participants completed the following measures during the quantitative phase of this study: QTI, PALS and a task-value scale. The dependent variables in the present study were the following sub-scales from the complete PALS instrument: two goal orientation scales (mastery and performance orientation) and the Academic Efficacy Scale. Students' reported task value was also a dependent variable in the study. Each scale was adapted to be science-specific. The independent variables in the present study were the QTI scales for cooperative teacher-students interactions (Leadership, Helpful/Friendly, Understanding, Student Freedom) and oppositional interactions (Dissatisfied, Admonishing, Strict, and Uncertain). Surveys were administered in the students' science class without their science teacher present, and each item was read aloud to control for reading level. Data were collected in the last quarter of the academic school year.

Quantitative Phase: Results

Descriptives

Descriptive statistics—including mean, standard deviation, variance, and range—were calculated for each variable. These statistics are presented in Table 2.

Reliability of Outcomes

Reliability for scales in the PALS and task value scale are presented in Table 3. The reliability coefficients for the scales ranged from a low, but acceptable, 0.6 to a high reliability of 0.85. Reliability for scales in the QTI are also presented in Table 3. The reliability coefficients for the QTI scales ranged from a low, but acceptable, 0.64 to a high reliability of 0.86.

Multiple Regression Analysis

Multiple regression analyses were conducted to evaluate how well student perceptions of cooperative and oppositional teacher behaviors predicted each of the four dependent variables (mastery orientation,

Table 3
Reliability (Cronbach's Alpha) for QTI scales

Scale	Reliability Coefficient
PALS Scales	
Mastery Orientation	.70
Performance Orientation	.83
Efficacy for Learning Science	.73
Value for Learning Science	.86
QTI Scales	
Leadership	.66
Helping/Friendly	.83
Understanding	.86
Strict	.73
Admonishing	.64
Dissatisfied	.71
Student Freedom	.62

performance orientation, efficacy for learning science, and value for learning science). The predictors were the QTI sub-scales measuring student perceptions of cooperative and oppositional teacher behaviors in the following dimensions: leadership, helping/friendly, understanding, student freedom, admonishing, strict, dissatisfied, and uncertain. Multiple regression analyses revealed that students' perceptions of teacher cooperative behaviors were significant predictors of students' efficacy for learning science, value for learning science, and mastery orientation.

The linear combination of student perceptions was significantly related to mastery orientation, $F(7,220) = 6.883$, $p < 0.001$. The sample multiple correlation coefficient was 0.43, indicating that approximately 18% of the variance in mastery orientation in the sample can be accounted for by the linear combination of student perception measures.

The linear combination of student perceptions was significantly related to performance orientation, $F(7,220) = 2.205$, $p < 0.05$. The sample multiple correlation coefficient was 0.260, indicating that only approximately 7% of the variance in performance orientation in the sample can be accounted for by the linear combination of student perception measures.

The linear combination of student perceptions was significantly related to mastery orientation, $F(7,220) = 5.044$, $p < 0.001$. The sample multiple correlation coefficient was 0.377, indicating that approximately 14% of the variance in efficacy for learning science in the sample can be accounted for by the linear combination of student perception measures.

The linear combination of student perceptions was significantly related to mastery orientation, $F(7,220) = 4.495$, $p < 0.001$. The sample multiple correlation coefficient was 0.359, indicating that approximately 13% of the variance in value for learning science in the sample can be accounted for by the linear combination of student perception measures. Table 4 presents bivariate and partial correlations for each dependent variable.

Table 4
Bivariate and Partial Correlations for Efficacy for Learning Science and QTI Scales

QTI scale	Mastery Orientation		Performance Orientation		Efficacy for Learning Science		Task Value for Learning Science	
	Bivariate	Partial	Bivariate	Partial	Bivariate	Partial	Bivariate	Partial
Leadership	0.36**	0.23	0.04	0.14	0.31 **	0.15	0.29 *	0.15
Helping/Friendly	0.29*	0.09	-0.06	-0.06	0.26*	-0.09	0.27*	0.08
Understanding	0.23	-0.04	-0.04	0.07	0.29*	0.11	0.20	-0.08
Student Freedom	-0.13	-0.20	-0.08	-0.01	-0.04	-0.10	-0.06	-0.15
Strict	-0.17	-0.05	0.13	0.04	-0.22	-0.07	-0.23	-0.14
Admonishing	-0.11	-0.11	0.17	0.17	-0.19	0.08	-0.14	0.09
Dissatisfied	-0.23	0.06	0.05	-0.04	-0.30**	-0.14	-0.23	-0.07

* $p < 0.05$
** $p < 0.01$

Data Mixing: Participant Selection

Following a sequential explanatory participant design, quantitative data from phase one informed participant selection for the qualitative component, phase two. To further examine the interaction between motivation and student perceptions of teacher interactions, quantitative data were examined to identify student participants who reported specified composites of motivation and perceptions of teacher behaviors. The decision to examine high and low extremes of these variables stemmed from a focus on understanding students' perceptions relating to higher and lower motivational profiles.

A summative score was calculated for student motivation using student scores from the motivation subscales in phase one (goal orientation, efficacy, and value). This summative score yielded a motivation variable that became the basis for assigning a motivational profile to each student participant.

In the quantitative analysis, cooperative teacher behaviors, as defined by the theoretical model of interpersonal behavior (Wubbels & Brekelmans, 2005), were the most highly correlated predictors of student motivation (mastery orientation, efficacy, and value). Thus, a summative score was calculated for student perceptions of teacher cooperative behaviors using the reported student scores for the following scales: helpful/friendly behavior, understanding behaviors, leadership behaviors. In this interpretation, a higher reported score for teacher cooperative behaviors indicated that the student reported more favorable perceptions of teacher behaviors in the areas of leadership, helpfulness, and understanding.

Once the summative scores for motivation and teacher cooperative behaviors were calculated, they were divided into quartiles to identify high and low ranges for each variable. Table 5 summarizes the scale high and low values, score ranges, and associated statistics for each selection variable. Student scores, identified by participant numbers, were then matched to identify students fitting the following motivation/perception composites: (1) high motivation/high perceptions of cooperative behaviors and (2) low motivation/low perceptions of cooperative behaviors.

Qualitative Phase: Method

Procedure

In phase one of this mixed methods study, results indicated that student perceptions of teacher-student interactions were predictive of their science motivation. The purpose of phase two was to explore how students constructed these perceptions of their teachers' interpersonal behavior. In addition, this qualitative phase also explored in greater detail how these perceptions of interactions with their teachers worked to shape students' motivation for science. Data for the qualitative phase of this study consisted of 24 student interviews. Participants were selected for student interviews based on survey results, as detailed above. A semi-structured interview protocol (Appendix A) was developed by drawing from constructs in the literature on students' perceptions of teacher-student interactions and subject-specific motivation and from findings from the quantitative phase of the study. Student interviews ranged in length from 15 to 35 minutes and were conducted in the school media center at a time that did not compromise the students' instructional time in the classroom. These interviews were recorded digitally and then transferred to a computer for transcription.

Data Analysis

Data analysis followed the constant comparative method, or the continual comparison of data (Strauss & Corbin, 1998). Using this method of analysis, data were analyzed as they were collected and then subsequent data were compared to emergent themes.

Table 5
Summary of Participant Selection Variables

Selection Variable	Lo	Hi	M	SD	Var.	Min	Max	Quartile1 Low	Q2	Q3	Q4 High
Student Motivation	8	36	28.09	4.7	22.2	8.0	36.9	8–25	25–28	28–31	31–36
Student Perceptions of Teacher Cooperative Behavior	12	60	40.52	8.4	70.8	12.0	54.0	12–35	35–43	43–47	47–54

These initial themes were then compared to successive interview data as categories and subcategories were refined. The steps of the constant comparative method utilized in this analysis were microanalysis, which involves in-depth line-by-line analysis of interview data; open coding, which involves identification of initial themes, categories, and subcategories; and axial coding, which involves elaboration of dimensions of categories and relationships between categories (Strauss & Corbin, 1998).

Qualitative Phase: Results

The qualitative phase of this study sought to answer the following research question: How do middle level science students construct perceptions of teacher-student interactions, and how do these perceptions affect their science motivation?

Data were collected and analyzed using the constant comparative methods as described by Strauss and Corbin (1998). Microanalysis—the in-depth, line-by-line analysis of interview data—preceded open coding of each interview; thus, data were coded and compared to previous data before conducting the next interview. Open coding was used to identify initial concepts, and similar concepts were grouped to create categories. This coding procedure was conducted by coding and naming initial concepts related to student perceptions of teacher interactions and science motivation as they emerged from student interview transcripts. Following the initial open coding phase of the analysis, 159 open codes were identified. These codes represented a wide range of dimensions related to students' construction of their perceptions of teacher interactions as well as their science motivation. Themes were grouped to create categories. This process allowed themes to be sorted into categories with unifying concepts, thereby joining initial themes into cohesive units. Figure 2 provides an example of how initial open codes were grouped to create a category and subcategories.

Consistent with the primary qualitative research question, this phase of analysis focused on identifying dimensions of students' construction of their perceptions of teacher interactions. The subsequent phase of axial coding delineated the relationship between student motivation and these teacher interactions. The results presented below detail the processes by which students construct their perceptions of teacher cooperative and oppositional interactions.

Open Codes	Category	Subcategories
Challenges with additional questioning	Construction of Perceptions of Teacher Cooperative Behavior: Helpful	(1) Instructional strategies
Detailed explanations		(2) Approachable/ supportive
Giving opportunity to correct tests		(3) Available
Keeping students informed		
Monitoring and scaffolding		
Planning interactive lessons		
Perceptive		
Sense of humor		
Plans engaging activities		
Gives help without student asking		
Pushes you to think		
Simple directions		
Supportive		
Teacher as expert		
Timeline on making up work		
Makes time for students		
Encouraging		

Figure 2. Grouping of Codes to Create a Category and Subcategories

Construction of Perceptions of Teacher Cooperative Behavior

Helpful. This category emerged as students described their interpretations of their science teacher's helpful behaviors. The following subcategories emerged as integral to students' construction of these perceptions of teachers' helpfulness: teacher's instructional strategies, approachable/supportive behaviors, and availability.

Students discussed instructional strategies as the primary aspect of their teacher's helpfulness. Students viewed the following instructional strategies as helpful in their learning of science: giving detailed explanations, using challenging questions, organization, keeping students informed of due dates and assignments, planning engaging activities, monitoring students during work, and using humor during instruction. One student described her teacher's organized use of notes: "Her notes are very specific and if there's something she knows is going to be on the test and it's going to be hard if you don't study it, she'll usually highlight it or remind us to highlight it." Another student described her teacher's helpful monitoring of students during classwork:

> Sometimes if you're doing classwork and you just kind of get a little sidetracked and not doing what you need to do, she'll come over and just kind of help you get back on track. And usually if you're doing that, you don't understand something and she'll help you get back on track.

Students also perceived approachability and supportiveness as integral aspects of a teacher's helpful behavior. Students described this support to be related to instruction and to general classroom dynamics. One student described his science teacher as supportive in relation to his behavior: "Like if we get in trouble, she tried to help us get out of it and not try to get in more trouble." Approachability was also deemed to be a critical aspect of teacher helpfulness: "She also tells us to ask any questions that we might have." Students described a helpful teacher as one who would not "get angry because we don't understand something."

A third subcategory of students' construction of their perceptions of teachers' helpful behavior was availability. Students described teachers as available if they made time to help students one-on-one and were willing to meet students before or after school. One student described her experience with her science teacher making herself available:

> One morning, there was this subject—and I don't really remember what—but I just did not understand it and I don't think a lot of students did. So that morning, she held this little meeting and you could come and she had these groups of activities where you could do these different things and understand it.

Understanding. This category emerged as students described their interpretations of their science teacher's understanding behaviors. The following subcategories emerged as integral to students' construction of teachers' understanding behavior: empathetic, slow to anger, individual attention, and wait time.

Students described teacher empathy as a key aspect in their perceptions of an understanding teacher. Students valued a teacher who "understands that we have five other classes and the work that we have to do." One student also described her teacher as understanding "because sometimes we have a lot of stress put on us with having to worry about projects and classwork and homework." Students perceived an understanding teacher as one who empathizes with the many challenges and stresses that students are facing and recognizes these experiences as legitimate and relevant.

A central aspect of students' perceptions of an understanding teacher centered on teacher affect: slowness to anger. This was especially true in relation to a teacher's propensity to display patience when students did not understand the content. One student stated: "She doesn't get mad at you for not understanding something." In addition, students viewed teachers as understanding if they were patient with student behavior: "Everyone was being extremely bad, like off the walls and everything…and most teachers would just yell and start threatening with detention. But she just asked us to be quiet nicely and told everyone to calm down."

Students also described understanding teachers as giving individual attention to students. This subcategory centered on students' need to feel that the teacher viewed them as individuals with individual needs; students felt that an understanding teacher would attempt to meet the needs of each student. One student described the importance of individual attention from her teacher: "There was once in the global wind chapter and I couldn't understand some of the winds. And it was like one day before the test. And

I had so many questions. But she patiently sat with me and went over each one of them." Other students echoed this theme, describing their science teacher as understanding because of the one-on-one time that she spent with them apart from whole class instruction.

Students also perceived teachers as understanding when they provided wait time, either during whole class discussions or during group or individual work. Students viewed wait time as a sign that their teacher was cognizant of their needs to process material without quickly moving on to the next question. One student described his science teacher as understanding because of her use of wait time during class discussions:

> Like when you don't know, and you take like ten seconds she won't pick on someone else, she'll stick with you. I mean, she's stayed with people for like two and three minutes before. I mean she sort of eases them closer to the answer and when they finally get the answer, then she goes and recaps like, 'How did you get that answer?'

Students also described their science teachers' understanding of their need for additional time to complete group and individual assignments. Students valued their teachers' understanding that the students' timetable was often different from the timetable the teacher has anticipated prior to the lesson.

Construction of Perceptions of Teacher Oppositional Behavior

Harsh/dissatisfied. This category emerged as students described their interpretations of their science teachers' harsh behaviors. Two subcategories emerged as integral to students' construction of their perceptions of teachers' harsh behavior: easily angered and unfair.

The most prevalent subcategory to understand students' construction of perceptions of a teacher as harsh was teacher affect; specifically, the teacher's ability to be easily angered. Students discussed this theme more than any other subcategories within any of the oppositional teacher behaviors. A typical response given by students when described a harsh teacher was "she gets mad easily." One student stated that a harsh teacher "has a temper problem" and another described a teacher who "has the ability to get mad fast." Students' perceptions of a harsh teacher as one who is easily angered affected the way in which students were willing to interact with their teacher during class. One student commented: "Sometimes I get scared to ask her questions because she yells at you when you ask her a question, so I'm like, 'Should I go ask her this?' So I'll just look in my notes if we're allowed to."

Students also described a harsh teacher as unfair. Students described how a harsh teacher will often get angry at the entire class for something that only a few students have done. One student described this scenario from her science class: "Sometimes she has a little temper problem, like if the class before us makes her mad." Students expressed their frustration that the teacher was being unfair to express anger for something a previous class had done. Other students commented that the class would frequently receive long lectures if just one or two students were misbehaving: "We get lectured a lot of the time so a lot of our time goes out because she lectures a lot (about behavior)." Students viewed this as unfair because it took away from time that they could be doing more hands-on and engaging activities in class.

Impatient. This category emerged as students described their interpretations of their science teacher's impatient behaviors. The following subcategories emerged as integral to students' construction of perceptions of teachers' impatient behavior: easily angered when students don't understand and not listening to students.

As with students' perceptions of teachers' harsh behavior, students mentioned teacher affect—the teacher's propensity to be easily angered—as a central aspect of their perceptions of impatient behavior. A key difference, however, was the focus of this subcategory. In relation to impatient teacher behaviors, students described a teacher who is easily angered when students don't understand science content. This differs from the more general subcategory, "Easily angered," for students' perceptions of teachers' harsh behaviors. One student described how her teacher reacts with students who don't understand material: "I don't like to ask her a question. Like I told my mom, 'My teacher yells at us when we ask questions.'" In contrast to students' view of a patient teacher as a teacher who is slow to anger when students need extra help, students perceived an impatient teacher as angry and unwilling to take the time to explain material that may be confusing to students.

Students also perceived an impatient teacher as one who is unwilling to listen to students. While students described a patient teacher as one who is empathetic, students viewed impatient teachers as unwilling to see their side of issues and unwilling to listen to students' viewpoints. One student described her teacher as unwilling to listen to details about her life: "We have a lot, like most of us do, a lot of afterschool activities and we don't have any time in our schedule to do a lot of homework and if we don't do it, then the next day she's like, 'Why didn't you do your homework?'" These students were also clear that they understood the importance of homework and assignments; they expressed a desire for their teachers to listen to them and try to understand when other aspects of their lives were overwhelming. This sentiment also related to the amount of work that they were expected to complete. Students tended to describe their teachers as impatient if they assigned "excessive amounts of homework" while not taking students' other courses into account. The majority of students wanted their teachers to listen to them instead of labeling student concerns as "just an excuse."

Student Motivation/Perceptions Composites

In the next phase of data analysis, which involved axial coding, relationships between the categories and subcategories were identified and properties and dimensions of the categories were elaborated in relation to student motivation composites. Specifically, student interview data were analyzed to examine patterns of responses within each motivation composite. For example, what commonalities existed within the subgroup of students who reported high motivation and high perceptions of teacher cooperative behaviors? In consideration of space constraints, these results are presented in Figure 3 and discussed below.

Discussion

Quantitative Phase

In phase one of this mixed methods study, significant positive correlations were identified between students' mastery orientation and their perceptions of their teachers' leadership and friendly/helping behaviors. Similarly, significant positive correlations were also identified between students' value for learning science and their teachers' leadership and friendly/helping behaviors. Positive correlations were also found between students' efficacy for learning science and their perception of the following cooperative teacher behaviors: leadership, helping/friendly, and understanding. In addition, a negative correlation existed between the oppositional teacher behavior of dissatisfaction and student efficacy for learning science.

These results support previous research suggesting that there is an interaction between students' perceptions of teacher interpersonal behaviors and motivation (den Brok et al., 2005; Pianta, 1999; van den Oord & Van Rossem, 2002). In the present study, students who perceived their teachers as helpful, friendly, and understanding were more likely to report high efficacy for science. These results extend the literature on teacher-student interactions and efficacy for learning science. Previous studies in science have focused more broadly on student attitudes for learning science. This finding is critical in light of the research indicating the relationship between efficacy and student achievement (Britner & Pajares, 2001; Pajares et al., 2000). In addition, efficacy has been related to other positive student factors such as perseverance in the challenging tasks and value for science (Britner & Pajares, 2001).

These results also support previous findings linking students' value to their classroom interactions (den Brok et al., 2005; Pianta, 1999; van den Oord & Van Rossem, 2002). Value is an integral aspect of the theoretical framing for motivation in the present study (Eccles, Wigfield, Midgeley, & Reuman, 1993; Eccles & Wigfield, 1994; Wigfield, 1994), and utility and intrinsic task value can affect students' effort in science as well as their course selection (Cole et al., 2006; Wigfield, 1994).

Results from the present study also indicated that students' perceptions of teacher interpersonal behavior were positively correlated with their mastery orientation for science. Research has demonstrated an interaction between a mastery goal orientation and student factors such as intrinsic motivation, persistence with difficult tasks, and healthy attributions for both academic successes and setbacks (Anderman & Young, 1994; Pajares et al., 2000; Ryan & Patrick, 2001). Studies have also shown that teachers can be highly influential in fostering the development of mastery goal orientations in their classrooms (Anderman & Young, 1994).

Qualitative Phase

During phase two of this study, students who reported high motivation and high perceptions of teacher cooperative interactions during the quantitative phase described the most instances of teacher cooperative behaviors, such as teacher helpfulness and understanding. Not only did these students describe their interactions with their science teachers more positively than students with low motivation, they also described positive interactions in much greater detail. These students reported high efficacy for learning science; they were confident in their abilities to learn science in general and also in their abilities to

HIGH MOTIVATION/HIGH PERCEPTION OF COOPERATIVE BEHAVIORS	
Cooperative Behaviors	Made the most references to cooperative behaviors in most detail
	Provided specific examples of their teachers using helpful instructional strategies and viewed their teachers as approachable and available both in and out of the classroom
	Defined teacher control as integral to maintaining order when necessary and not allowing the class to get out of hand
Oppositional Behaviors	Made the fewest references to oppositional behaviors
	Reflected on oppositional teacher behaviors in reference to the class as a whole
Efficacy for Learning Science	Highest efficacy for learning science and for difficult tasks
	Tended to attribute their confidence for learning science to teacher factors
	Reported the highest level of efficacy for approaching difficult tasks and noted specific strategies for dealing successfully with these tasks (i.e., seeking out helpful resources and peer assistance)
Value for Learning Science	Highest intrinsic and utility value (present and future)
	Valued science as a means for understanding the world around them
	Described science as relevant to career goals
LOW MOTIVATION/LOW PERCEPTION OF COOPERATIVE BEHAVIORS	
Cooperative Behaviors	Made the fewest references to cooperative behaviors
	Tended to view teacher control as negative; frequently referenced instances of teacher singling students out for misbehavior
Oppositional Behaviors	Made the most references to oppositional behaviors in most detail
	Reflected on oppositional teacher behaviors in reference to their own personal experiences
Efficacy for Learning Science	Lowest efficacy for learning science and for difficult tasks
	Expressed low efficacy for meeting the more demanding subject matter of middle school science
	Tended to attribute their lack of confidence to increased difficulty in content and a shift in instructional styles to more lecture, less engaging activities
	Lacked efficient strategies for approaching complex tasks; reliant on one-on-one teacher assistance
Value for Learning Science	Lowest intrinsic (teacher factors) and utility value (present and future)
	Described science knowledge as important solely for the purpose of completing classwork and homework assignments
	Viewed science as disconnected and unrelated to future goals
	Attributed their negative sentiment toward science primarily to teacher factors

Figure 3. Comparison of Motivation/Perceptions Composites

complete difficult tasks. Students with high motivation tended to rely on their own problem-solving skills and self-reflection when facing these difficult tasks. In addition, students with higher motivation attributed their positive intrinsic value for science to teacher factors, such as personality and support.

Students with high motivation and high perceptions of teacher cooperative behavior in science also tended to have a positive view of their transition to the middle grades. They valued the increased responsibility in their science classes and enjoyed the challenge of more in-depth content. These students were also thriving in environments that encouraged independence in students. Perhaps these students were better equipped with the organizational skills necessary to navigate the unique challenges of the middle grades (e.g., multiple teachers for multiple subjects, changing classes, managing multiple assignments in different content areas).

Conversely, students who reported low motivation and low perceptions of teacher cooperative interactions described the most instances of teacher oppositional behavior, such as harsh/dissatisfied and impatient behaviors. These students frequently reflected on negative teacher-student interactions with their science teachers and described these interactions in detail. Students with low motivation reported low utility value for science, valuing science primarily for grades as a "means to an end" rather than valuing science for its benefits to their current and future lives. Many students recognized that they would need good grades in science to be able to pursue other goals, such as playing college sports. In addition, these students were not confident in their abilities to learn science or to complete difficult tasks in science.

Students with low motivation and low perceptions maintained a general negative intrinsic value for science and attributed their feelings to teacher behaviors such as giving excessive work and getting angry when students asked questions. Interestingly, these students reported that their primary strategy for approaching difficult tasks in science was to seek teacher help. These students did not mention using any of the problem-solving skills and self-reflective strategies cited by the students who reported high motivation. Perhaps these students' increased reliance on their teachers for assistance contributed to expectations that differed from students who required less teacher guidance.

Students who reported low motivation for science were also more negative about their transition to the middle grades. While students with high motivation viewed added responsibility as an opportunity for more independence, student with low motivation tended to be overwhelmed by increased workloads and new teacher expectations. These students frequently mentioned the fact that their middle level science teachers did not do as much to help them with organization and expected them to keep track of more due dates and assignments. In general, students with low motivation for science were experiencing more difficulty with managing the structure and increased independence of the middle grades.

Theoretical Implications

The current study identified a positive correlation between students' perceptions of teacher interpersonal behavior and their science motivation. Specifically, efficacy for learning science had a significant positive relationship with all subscales of teacher cooperative behavior. Bandura (1977, 1997) theorized that several key experiences contribute to an individual's self-efficacy for any given domain. These areas include mastery experiences, vicarious experiences, social persuasion, and physiological states. Social persuasion is especially relevant to the current study and its focus on teacher-student interactions because the teacher is often a powerful source of social persuasion for students. Teachers who communicate positive messages to students about their abilities can foster an increase in the students' self-efficacy. However, Bandura postulated that it is easier for social persuasion to decrease an individual's self-efficacy for a task than to increase it. Consequently, when students receive negative appraisals of their ability from their teachers, as in oppositional interactions, their self-efficacy can decrease to a greater degree than it might increase with a positive appraisal.

In the current study, many students who reported low efficacy for science also reported negative interactions with their teachers, often noting teacher dissatisfaction when students did not understand concepts. When students receive negative feedback in conjunction with confusion about science concepts, their self-efficacy may suffer. Furthermore, students who reported high efficacy for learning science also discussed positive interactions with their teachers, such as verbal encouragement and specific support in understanding science concepts. In light of Bandura's concept of social persuasion, it is conceivable that teachers played a pivotal role in helping to foster students' efficacy for learning science when their interactions were perceived positively, but played an even stronger role in contributing to a decrease in student efficacy when their interactions were perceived negatively.

Student value for learning science was also positively correlated with cooperative teacher interactions. Research indicates that students' task value can be predictive of their achievement, course selection, and effort (Cole et al., 2006; Wigfield, 1994). In the current study, students who reported positive interactions with their teachers also reported high task value for science. Conversely, students who reported negative interactions reported low task value for science. Qualitative interviews revealed the dimensions of utility and intrinsic value; students discussed both the usefulness of science in their lives and their enjoyment of science. Interestingly, students who reported a high utility value for science generally also reported a high intrinsic value for science, and vice versa. In other words, students who saw the value of science in their daily lives or for the future also enjoyed science. This finding raises the following question: Does utility value influence intrinsic value or it is the other way around? For example, do students enjoy science because they see the usefulness of the subject, or do they see the usefulness of science because they enjoy it? The other side of this question is more daunting: Do students dislike science because they do not see its usefulness, or do they fail to see the usefulness because they dislike the subject? Perhaps the relationship between these two forms of task value is reciprocal, with each exerting influence on the other. This relationship between students' utility value and intrinsic value for science could be explored in future studies.

Implications for Educational Practice

The most critical implication for middle level science educators from the current study is the potential teachers have to affect elements of student motivation for learning science. Though we cannot say that teachers' interactions necessarily influence motivation for all students in all contexts, teachers should nevertheless develop an awareness of the way in which their interactions with students might shape student motivation, particularly students' efficacy for learning science and their value for the subject. Students in the current study indicated an acute awareness of their teachers' cooperative behaviors. Conversely, students were also aware of teacher impatience and frustration when students didn't understand content. These negative interactions most often were perceptions of students who had low intrinsic value regarding science and a lack of confidence for their abilities to be successful in science. Considering the relationship between teachers' interactions and student motivation in science, teachers should be cognizant of the ways that they interact with their students. Students generally interpret tight classroom control, teacher propensity to anger quickly, and unwillingness to listen as negative teacher behaviors. Alternately, students generally perceive availability, approachability, and individual attention as positive teacher behaviors. In other words, students are more likely to report high motivation for science when they feel that their teacher is patient and willing to take the time to listen to their individual needs.

An unanticipated finding from the current study is the role of middle level students' prior experiences in elementary grades and how these may affect their expectations of their teachers. These expectations can consequently affect student perceptions of teacher-student interactions in the middle grades. Upon entering the middle grades, some students have developed strong problem-solving skills that allow them to be more independent and less reliant on teacher assistance in confronting difficult tasks. This may predispose these students to have different expectations of their teacher, possibly resulting in different perceptions of teacher behavior than students who lack skills for working independently. It is difficult to identify the mechanisms that precipitate the development of these more self-reliant behaviors; however, students who possess these skills seem to perceive their teachers differently from students who are more dependent on teacher assistance. Students who report low motivation for science tend to be the most reliant on teacher help and the most critical of their teachers for not providing this needed assistance. Ironically, these students' perceptions of their teachers as harsh and unapproachable lead them to abandon their primary strategy for dealing with complex tasks, asking for teacher help. This cycle can leave students with low motivation and limited strategies for dealing with difficult tasks, thereby raising the probability that they will experience failure on these tasks. In order for efficacy to increase, students need to experience small successes (Bandura, 1977, 1997); these successes may be especially critical for students with low motivation and low efficacy for science. Thus, it is problematic when students with low motivation perceive their teachers as unapproachable and abandon their primary success strategy—seeking help from the teacher.

Students with low motivation constructed their negative perceptions of teacher interpersonal behavior primarily through their views of their teacher as easily angered, unfair, and unwilling to listen. These descriptions highlight the importance of teacher control philosophies and how teachers convey varying levels of control to their students. Teachers who are more authoritarian tend to maintain a tight rein on all aspects of the classroom. This can include enforcing procedures, controlling the pace of the lesson, and restricting student movement and active involvement. Previous studies have indicated that students often perceive these authoritarian teacher control styles negatively (Morris-Rothschild & Brassard, 2006; Tollefson, 2000). When considering the primary aspects of oppositional teacher behaviors that students cited in the present study (anger, unfairness, lack of listening), it is conceivable that these characteristics could be indicative of an authoritarian system of classroom management. Student-centered classroom management models are correlated with more positive student judgments of interactions with their teachers (Lewis, Romi, Qui, & Katz, 2005). Students report positive interactions with a teacher who is approachable, fair, in control without being authoritarian, engaging, and interested in student ideas and points of view. In-service training and professional development in student-centered classroom management models could help to increase teachers' awareness of the way in which their management style can affect student perceptions and consequently, their motivation.

The transition to the middle grades also has implications for both student motivation and teacher-student interactions. All students reported an awareness of an increase in difficulty and expectations in middle level science. Students who were equipped with organizational skills for managing multiple teachers and classes experienced a more positive transition and reported higher motivation for science. Students who lacked these skills for organization and coping were in need of additional scaffolding. Teachers have the ability to scaffold this transition; cooperative teacher behaviors may help students to make this transition more smoothly. Students who were struggling with this transition to the middle grades did not perceive their teachers as supportive, helpful, or understanding. Additional supports from teachers and guidance staff could help all students to better navigate this transition, especially those students who need additional assistance in developing personal skills necessary for success in the middle grades.

Student motivation for learning science is a complex construct. The results of this study indicate a significant relationship between students' motivation for learning science and teacher interpersonal behavior. However, this is one piece in a complex array of factors affecting student motivation for learning science. Previous research indicates that teacher-student interactions are mediated by a host of other factors, including student factors, peer factors, family factors, school factors, and cultural factors (Bronfenbrenner, 1977; Pianta, 1999). Future research into the impact of these factors upon student motivation for science in the middle grades is critical to developing a more comprehensive understanding of how to facilitate and support student motivation during the middle grades and beyond. Since motivational patterns can remain stable after the middle grades (Eccles & Midgley, 1989), this is a critical time to support students' efficacy for science, task value for science, and optimal goal orientations. Results from the current study provide evidence of a potentially powerful relationship between teacher-student interactions and these key components of motivation for learning science.

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