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Teacher-Child Relationships and Interactions in Third-Grade Science Lessons

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Abstract

This naturalistic observational study examined teacher-child interactions in a third-grade science classroom. Of interest was the extent to which the quality of teacher-child relationships was associated with various categories of interaction, and students' understanding of science concepts. Teacher-child relationships of an intact class of 17 third-grade students were measured using the Student Teacher Relationship Scale (STRS). A series of science lessons were audio/video recorded, transcribed, and all interaction coded into one of 12 categories. Students' understanding of science concepts was measured using teacher administered pre-, and posttests. The analyses identified gains in students' understanding of the science content, and a positive correlation between teacher-child relationships and the quality and quantity of their classroom interactions. The findings are discussed in terms of the importance of teacher-child relationships in shaping classroom talk and dialogue patterns during science instruction.

Keywords: Teacher-child interations, elementary school, science, classroom interaction

Introduction

It is well established that science teaching and learning in the early grades is an active process in which learners construct their own understanding through making sense of their experiences (Seefeldt, Galper, & Jones, 2012).

Rather than passively absorbing knowledge, children learn while engaging in meaning making processes by way of social interactions (Airasian & Walsh, 1997; Simon & Schifter, 1991). Simply put, children's interactions with adults and among themselves can provide important opportunities for learning and conceptual understanding (Mercer & Littleton, 2007). The current study examined such interaction during science teaching and learning in a third-grade classroom. Using observational research methods, the study explored the nature and quality of teacher-student interactions in a third-grade science classroom and examined the extent to which interactions and teacher-child relationships were related to the learning of science concepts.

Science activities with young children are both constituted and enriched by relevant conversations (French, 2004; Jones, Lake, & Lin, 2008). In other words, during children's socialization into science, conversation between children and adults, as well as between peers, become crucial to scientific participation. This is because social interaction is the primary route by which a child reflects on the meaning of his or her experiences, and it is through social exchanges that children develop and refine their science process skills. In short, it is through oral language that children come to understand science concepts. Children's language use, however, occurs within the social contexts of classrooms; that is, contexts that are complex, characterized and shaped by social relationships, and that situate thinking and speaking in activity.

Classroom Contexts

The classroom is one important context where children's learning and understanding is developed. The early childhood classroom, however, is a uniquely complex social context, with its own set of routines, expectations, and values that are shaped by the participants. This is true for children and adults alike. While there are both social and non-social aspects of the classroom context, they are essentially in a dialectical relation with each other; that is, each influences the other. In addition, both the social and non-social aspects influence each other over time. Most classrooms have their own goals, routines, and expectations for interaction that can be defined as social or non-social.

Social interaction in the classroom environment is shaped by the ways students and teachers talk to each other when engaged in classroom instruction and activities. Teaching itself requires teachers to use language and classroom talk to stimulate student interest and learning in general and create opportunities for students to reflect on their understanding of the various topics. From a socio-cultural perspective, teachers are considered mediators who, through talk, provide opportunities for collective classroom practices that are culturally and historically situated (Wertsch, 1998). Communication among learners and educators is seen as a necessary part of learning from the perspective of socio-cultural theories (Vygotsky, 1978).

It is believed that social interaction and participation in social exchanges is necessary for internalization of learning (Rogoff, 1995; Wells, 2000), and students' interest in learning is strongly influenced by their teachers' behaviors in the learning environment (Wubbels & Levy, 1993).

Teacher-Child Relationships

As a complex system, the classroom consists of the teacher, the students, and teaching and learning acts between them. It is believed that teachers who create and maintain a positive relationship with students are more likely to utilize effective teaching strategies and establish necessary norms for successful classroom management (Hamre & Pianta, 2005). Positive teacher-student relationships are considered essential for creating quality learning environments, and it is strongly related to students' motivation and academic outcomes (Birch & Ladd, 1997; Brekelmans, Wubbels, & Brok, 2002). Student interest and engagement in learning activities are also a result of healthy teacher-student relationships, which in turn can affect student achievement and performance (Brekelmans et al., 2002; Wubbels & Levy, 1993). Although it is well established that teacher-child relationships are important in elementary classrooms, little is known about how teacher-student relationships affect student outcomes in all subject areas, particularly in science (Lynch & Cicchetti, 1997).

Close teacher-child relationships, as well as close adult relationships evidence more trust and mutuality (Sabol & Pianta, 2012) and, consequently, more reflection and use of metacognitive language (Boise, Knoche, & Sheridan, 2017). Arguably, teachers who have a secure and trusting relationship with their students will use more appropriate and supportive teaching strategies. In turn, the trust manifested in these types of relationships should allow children to take risks and be more open-minded in their thinking. Thus, the reflection that is considered an important part of science learning occurs within a social context, and it is more likely to be amplified when it is bound within the secure confines of a safe, trusting relationship.

Classroom Talk

Children learn through their social interactions and communications with others (Watkins, 2006). In classrooms, teacher-student talk is a powerful way of establishing quality teacher-student interactions and supporting student understanding in science. Teachers can foster student learning and help children make sense of their own thoughts through talk. Quality teacher student interactions that are present in classroom talk increase the likelihood of students developing a well-founded scientific understanding (Newton, 2002). During traditional lessons, classroom talk usually takes place in a three-step sequential dialogue between students and the teacher. This three-step sequence of talk starts with teacher initiation, and is followed by student response and teacher evaluation or teacher feedback. As educational goals change and become more complex, the classroom talk and complexity of dialogue patterns between students and teachers also evolves. Instead of following a strict sequential pattern of teacher initiation - student response - teacher evaluation, many teachers strive to use classroom discourse that is more open and talk that promotes inquiry and discussion. In non-traditional student-centered classrooms, classroom talk does not necessarily fit to an initiation-response-feedback structure, and students can reflect on each other's responses and collectively inquire solutions to problems. As a classroom learning community, students explain and share their views in order to validate their responses and ideas through interaction with peers and teachers. Within such classrooms the teacher is more of a facilitator of such validation, rather than being the sole authority (Cazden, 2001).

Teachers who have high expectations of their students and who support their students' communicative efforts contribute to the quality of classroom interaction (Cazden, 2001). In contrast, vagueness in teachers' classroom talk can increase children's frustration and potentially lead to academic failure (Watson, 1996). Spending excessive time telling students what to do during activities often gets the task done for both the teacher and students. However, such interaction neither pushes for meaningful progress in students' thinking nor their reasoning and understanding (Parker-Rees, 1996). Research reveals that teacher-student conversations are often quite brief and dull, and disappointingly unrewarding for both teachers and students. The length of a conversation between teacher and child does not necessarily mean that it is also quality interaction (Watson, 1996). The quality of the educational talk that takes place in the classroom and its effects on students' educational success or failure are of considerable importance. Thus, accomplishing better student outcomes requires attention to the relationship between language, thinking, learning, and cognitive development (Mercer & Littleton, 2007).

Observing Classroom Interaction

The current study investigated the research questions from a sociocultural perspective and therefore utilized an approach that allowed moment-by-moment recording and analysis of interactions, or real time analysis of talk, as it occurred during science lessons. Observation of each teacher student interaction that takes place during classroom activities, and the way teachers interact with their students through classroom discourse, should inform researchers as they strive to understand how children learn science concepts. In the current study, the representative sample of interactions which the researcher observed and recorded during science lessons provided a picture of teacher-student interactions which could potentially influence students' science learning. Detailed analyses of teacher student interactions and the content and nature of classroom conversations are important so that we can better understand how children learn science content in classroom contexts. It follows that examining the roles of both teachers and students during verbal interaction can provide the basis for judgments about student learning (Hamre & Pianta, 2001; Newton, 2002; Watson, 1996).

The purpose of the study was to explore the nature and quality of teacher-student interactions in a third-grade science classroom and to investigate their connections to teacher student relationships and student learning. It is important to examine teacher-student interaction and dialogue patterns during instruction because it is not only necessary for determining the factors that may influence students' science understanding, but also for identifying the type and nature of teacher-student interactions that may inhibit or stimulate students' learning in science. The primary focus of the study was to explore the relationships between teacher-student relationships, and teacher-student interactions and student learning.

Method

The intent of this quantitate study was to investigate teacher-student interactions in a naturalistic setting. To this end the everyday context of the classroom activities and interactions was used to address the research questions. The purpose of the study was not to impose a treatment on a particular group of students, or determine the differences between a control and treatment group. Rather, the study sought to identify the nature and quality of interactions that took place during science lessons in a real time environment. The natural observation of the classroom allowed the researcher to observe teacher-student interaction exactly as it occurred in the classroom.

Teachers interact with each of their students several times during a single lesson and investigation of each verbal exchange and determining the nature of that exchange requires the recording and analysis of an extensive amount of data. It is common in quantitative research that a much smaller group of participants is used to gather data (Gall, Gall, & Borg, 2007). In the current study, the representative sample of interactions which the researcher observed and recorded during science lessons provided a picture of teacher-student interactions which can potentially influence students' science learning.

Participants

Participating in the study was an intact class of 17 (10 female and 7 male) third grade elementary school students and their teacher. The majority of the children were 9 years old and the mean age was 8.88 (SD = 0.33). The participants' race was as follows: African American 41.2%, White 41.2%, and Hispanic17.6%. The classroom teacher was a white female who had been teaching at the school for nine years.

The setting for the study was a student-centered, inquiry-based elementary school science classroom where teacher-student interaction was evident during classroom activities. The study was conducted in a K-12 laboratory charter school sponsored by a southeastern university that provides extensive research and development opportunities for educators. The school currently serves approximately 1700 students from the surrounding county, and the student demographics are similar to other typical school sites in the State.

Procedures

The study required the researcher to record, transcribe and analyze the audio and video recordings of each conversation between a specific child and the teacher during the science lessons for a period of eleven class sessions in a third-grade elementary classroom. The first two class sessions of the observations served as preliminary observations in order to reduce potential observer effects. The initial data collected were used to determine the appropriateness of the proposed interaction-types and their classification into the various categories. The researcher used both audio and video recording to capture the classroom interaction. Such an approach provides better opportunities for accurate examination of the complex nature of teacher-student interactions during science lessons.

The researcher set up the camera toward the back of the classroom in a location looking towards the teacher and students, so that all interactions could be viewed and recorded. The researcher clipped an audio recorder to the teacher and used it as a backup source for those conversations that were less audible in the video recording due to classroom noise. The use of two types of recorders allowed the researcher to record all types of conversational teacher-student interactions that occurred during the instruction, regardless of where it occurred within the classroom. As such, the researcher was able to capture all conversations within a loud classroom environment, including the quiet conversations of students located some distance away from the camera.

Prior to observing the science unit lessons a pre-test, developed by the teacher, was administered to the students. Next, each of the science lessons was observed, recorded, and subsequently coded. No field notes were taken during the observations. Furthermore, the researcher did not discuss the lessons or observations with the teacher, either before or after the class sessions. Finally, a teacher developed posttest was administered to the third-grade students.

The researcher conducted a total of nine hours of observations during the science unit. The duration of the observations depended on the amount of time devoted to science instruction. After collecting the data, the researcher transcribed all of the audio and video recordings and the teacher-student interaction that took place during the instruction was subsequently coded into the appropriate interaction type.

Science lessons. The researcher collaborated with the classroom teacher in developing a science unit on the solar system. This topic was considered suitable for the purposes of the current study since it would potentially provide many opportunities for teacher-student interactions. The science unit was a section of the third-grade science textbook that had been adopted by the school district. The science unit covered concepts related to the topic of the solar system and it was designed to answer basic questions such as; *"What patterns do the Earth, Sun, Moon, and stars show?"* and *"How are the planets in the solar system alike?"* Some of the Florida science benchmarks for the science unit were:

- The student knows that most things that emit light also emit heat.
- The student knows that the tilt of the Earth on its own axis as it rotates and revolves around the Sun causes changes in season, length of day, and available energy.
- The student knows that the combination of the Earth's movement and the Moon's own orbit around the Earth results in the appearance of cyclical phases of the Moon.
- The student knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

The lessons were each planned by the classroom teacher and designed to address broad objectives such as:

The student will be able to:

- make predictions and inferences based on observations.
- understand that the Sun provides energy for the Earth in the form of heat and light.
- explain how the movement of Earth in relation to the Sun determines the pattern of day and night.
- understand that days and nights change in length throughout the year
- know the patterns of average temperatures throughout the year.
- explain how the Moon and Earth interact.
- describe ways to study stars. The student explains how constellations are in patterns that are stable.
- know that, in addition to the Sun, there are many other stars that are far away.
- know the relative positions of all the planets.
- know characteristics of Mercury, Venus, Earth, and Mars.
- know that the planets differ in size, characteristics, and composition and that they orbit the Sun in our Solar System.

The class sessions were taught during a three-week period, and each lesson lasted approximately thirty-five minutes. The lessons included video presentations of the solar system. The students also had an opportunity to observe and record shadow movements in the school yard. Additionally, students were asked to draw the phases of the moon for homework. As part of a hands-on activity, students were asked to act as planets and the sun to simulate the movements of the planets in the solar system. During four of the class sessions the teacher asked the students to read aloud from the textbook for about ten minutes. In addition to whole class instruction, the teacher also assigned group work and engaged the students in whole class discussions. The students were provided an opportunity to freely share their ideas and views during the whole class discussions.

Instruments and Measures

For each participant, three types of data were collected: Conceptual understanding of science, teacher-child relationship, and teacher child interactions. The teacher rated each participant child in her classroom by completing a survey instrument that measured the teacher's perceptions of teacher-child relationships. Teacher-child interactions were assessed through natural observations. Conceptual science understanding scores was measured by administering pre- and post-tests at the beginning and end of the series of science lessons.

Student-teacher relationship scale. The Student-Teacher Relationship Scale (STRS) (Pianta, 2001) was administered to measure the quality of teacher-student relationships. The STRS is a widely used teacher scale that assess the quality of the relationship between a teacher and a particular student. The STRS is designed to measure teachers' perceptions of their relationship with their students and is validated for use with teachers of students from age 4 to 9 years. The scale consists of 28 Likert type items using a 5-point rating. Teacher ratings for each item are; *definitely does not apply* (1), *does not really apply* (2), *neutral or not sure* (3), *applies somewhat* (4), and *definitely applies* (5).

The STRS consists of three dimensions measuring the quality of relationships; closeness, conflict, and dependency. The closeness subscale consists of 11 items and measures the perceived warmth, openness and emotional support between the teacher and the student. The conflict subscale consists of 12 items and serves as a measure of perceived unfriendly, discordant, and uncooperative interactions between the teacher and the student. The dependency subscale consists of 5 items and assesses the degree to which a student is perceived as overly dependent on the teacher.

Pianta (2001) has reported high reliability and validity for the STRS (i.e., internal consistency reliability of .89 is reported for the total scale). As the only standardized and validated instrument assessing teachers' perception of their relationship with students (Pianta, 2001), STRS has been extensively used in studies of teacher student relationships (e.g., Birch & Ladd, 1997, 1998; Kesner, 2000, 2002; Pianta, Steinberg, & Rollins, 1995).

Teacher-student interactions. The researcher developed and used a classification system based on research findings suggesting children's social competence and understanding improve as they interact with more knowledgeable others (Watson, 1996). The classification system consisted of twelve types of interactions categorized into two different groups (nature and quality). The interaction codes were as follows:

1. Closed Question (CQ) - to diagnose student understanding, information seeking, require short answer or recall (e.g., Flanders, 1970; Wood, 1992).

2. Open-ended Question (OQ) - to extend student ideas, leading to higher order thinking and reasoning (e.g., Alexander, 2011; Cohen, 1994; Flanders, 1970; van Boxtel, van der Linden, & Kanselaar, 2000).
3. Scaffolding Questions (SQ) - to further elaborate student ideas, series of questions back and forth, exchange of ideas between the teacher and the student (e.g., Alexander, 2011; Fernandez, Wegerif, Mercer, & Rojas-Drummond, 2001; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003; Wood, Bruner, & Ross, 1976).
4. Clarifying (CL) - to make a comment on a response or a question with an intention of understanding/teaching or feedback. (e.g., Student states *"If penguins were birds they would fly."* The teacher states *"Not all birds can fly, like penguins and ostriches. They have lost their ability to fly in time and live on ground. But they are still birds…"*) (e.g., Flanders, 1970).
5. Restating (RS) - to restate student answer or question in an effort to attract student/s attention to the answer or the question. (e.g., *"So, the longest river in the US is the Mississippi river"* or after a question of a student *"Which one is bigger the sun or the moon?"* the teacher restates *"Yes, which one you think is bigger, the sun or the moon"*) (e.g., Hogan, Nastasi, & Pressley, 1999; Walsh, 2006).
6. Praise (PE) - to express warm approval, setting a good example for others. (e.g., *"Nice drawing Alan, keep up the good work!"*) (e.g., Becker, 1981; Flanders,1970; Mercer & Littleton, 2007).
7. Positive Comment (PC) - to express approval, praising, encouraging, expression of satisfaction (e.g., Teacher: *"Do you know what city we are in now?"* Student: *"Tallahassee"* Teacher: *"Good"* and teacher turns way and continues his/her lesson) (e.g., Flanders, 1970; Mercer & Littleton, 2007).
8. Negative Comment (NC) - to express disapproval, expression of dissatisfaction. (e.g., *"You did not listen well yesterday, and now you do not understand what I say"*) (e.g., Flanders, 1970)
9. Directive Comment (DC) - to state a command or request certain behavior to be presented. (e.g., *"I want you to open to page thirteen in your book"*) (e.g., Flanders, 1970; Swann, 1992).
10. Disciplinary/Warning Comment (DWC) - to a set or system of rules and regulations, enforcing for certain behaviors. (e.g. *"Julie I won't warn you again, sit down!"*) (e.g., Flanders, 1970).
11. Minimal or No Comment (MC) - to express frustration, or lack of knowledge with no comment or help. (e.g., The teacher asks, *"Do you know of a mammal,"* one student answers *"lizard,"* the teacher either says no or simply turns around and looks for another student to answer) (e.g., Hughes, 1973; Patchen, 2006; Ryan, Gheen, & Midgley, 1998).
12. Individual Instruction (II) - to further improve student understanding, providing additional help for catch up (e.g., Becker, 1981; Rodgers, 1988).

The 12 categories of interaction were further classified into two types. The first type is the nature of the interaction which consisted of three dimensions; positive, negative and neutral. The positive interactions group includes the interaction types of; Positive comment (PC), Praise (PE), Individual instruction (II), Open-ended question (OQ), Scaffolding questions (SQ) and

Clarifying (CL). The negative interactions group includes the interaction types: Negative comment (NC), Disciplinary/warning comment (DWC), Minimal or no comment (MC). The neutral interactions group includes the interaction types of; Closed questions (CQ), Restating (RS) and Directive comment (DC). The second type of interactions reflected the quality of the teacher student interactions. Here, there were two dimensions: higher quality interactions and moderate quality interactions. The higher quality interactions group included the interaction types of Open-ended question (OQ), Scaffolding questions (SQ), Praise (PE), Individual instruction (II), and Clarifying (CL). The moderate quality interactions group includes the interaction type of Positive comment (PC), Negative comment (NC), Disciplinary/warning comment (DWC), Minimal or no comment (MC), Closed questions (CQ), Restating (RS) and Directive comment (DC).

To establish inter-rater reliability a second observer was trained by the researchers during the preliminary observations phase of the study. All the definitions and interaction categories were explained in detail to the second observer. The researcher and the second observer individually watched one of the preliminary observations from the videotapes. Each coder transcribed the video and coded the teacher-student interactions to the appropriate categories. The researcher and the second observer continued to code and recode the videotape until 80% agreement was reached.

Science pre- and post-tests. Students' learning of concepts during the science unit was measured by administering pre- and posttests developed by the researcher and the classroom teacher. The pre- and post-tests consisted of forty multiple-choice questions developed to evaluate the students' understanding of the concepts covered in the science unit.

Results

In order to comprehend the nature and quality of teacher-child interactions, the observations were analyzed in terms of teacher-student interaction and dialogue patterns. Descriptive statistics for the 12 teacher-student interaction categories are reported in Table 1 (next page). The nature of teacher-student interaction category included three dimensions: positive interaction, negative interaction, and neutral interaction. The frequencies for the nature of interactions are reported in Table 2 (next page).

Descriptive statistics were computed for each of the three Teacher Student Relationship Scale (STRS) subscales (Conflict, Closeness, and Dependency), and also for the total STRS score (Table 3). Pearson Product Moment correlations between teacher-child interaction (nature of interaction and

Table 1
Descriptive Statistics for Teacher-Child Interaction by Interaction Type

	N	Range	Minimum	Maximum	Mean	SD	Total Interaction
PE	13	4	1	5	2.00	1.354	26
PC	17	22	2	24	9.82	5.626	167
CQ	17	25	3	28	14.29	6.734	243
OQ	16	18	3	21	7.50	4.561	120
SQ	13	8	1	9	2.85	2.304	37
MC	8	4	1	5	2.38	1.768	19
NC	17	5	1	6	2.47	1.736	42
DC	17	15	3	18	10.41	4.757	177
RS	16	8	1	9	3.81	2.482	61
CL	15	7	1	8	3.87	2.386	58

Table 2
Descriptive Statistics for Teacher-Child Interaction by Nature of Interaction

	N	Range	Minimum	Maximum	Mean	SD	Total Interaction
NI_Positive*	17	48	5	53	26.71	13.298	454
NI_Negative**	17	17	2	19	7.76	5.093	132
NI_Neutral***	17	48	7	55	28.29	12.139	481

Table 3
Descriptive Statistics for the measure of teacher student relationship (STRS)

	N	Range	Minimum	Maximum	Mean	SD
Conflict	17	9	51	60	59.29	2.201
Closeness	17	14	37	51	47.00	4.704
Dependency	17	2	23	25	24.59	.712

quality of interaction) and teacher-child relationship (Conflict, Closeness, Dependency) were computed. The results are first presented by Nature of interaction (positive interaction, negative interaction and neutral interaction) dimensions (Table 4 on the next page) and then by Quality of Interaction (high quality interaction and moderate quality of interaction) dimensions (Table 5 on 52).

Examination of the pre- and post-test data indicate that students' conceptual understanding related to specific science unit improved during the science lessons. Pearson Product Moment correlations were computed to investigate any relationship between teacher-child interactions and students' conceptual understanding of science. There were no significant

Table 4

Nature of Interaction – Teacher-Student Relationship Correlation

		Teacher-Student Relationships				Nature of Interactions			
		Conflict	Closeness	Dependency	Total STRS	Positive	Negative	Neutral	Total Interaction
Conflict	Pearson Correlation	1							
	Sig. (2-tailed)								
Closeness	Pearson Correlation	.567*	1						
	Sig. (2-tailed)	.018							
Dependency	Pearson Correlation	.600*	.187	1					
	Sig. (2-tailed)	.011	.473						
Total STRS	Pearson Correlation	.814**	.935**	.447	1				
	Sig. (2-tailed)	.000	.000	.072					
Positive	Pearson Correlation	.396	.416	.521*	.491*	1			
	Sig. (2-tailed)	.116	.097	.032	.045				
Negative	Pearson Correlation	.079	.493*	-.218	.359	.395	1		
	Sig. (2-tailed)	.763	.044	.401	.157	.117			
Neutral	Pearson Correlation	.457	.449	.318	.514*	.664**	.639**	1	
	Sig. (2-tailed)	.065	.071	.213	.035	.004	.006		
Total Interaction	Pearson Correlation	.425	.511*	.367	.553*	.885**	.686**	.917**	1
	Sig. (2-tailed)	.089	.036	.148	.021	.000	.002	.000	

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 5

Quality of Interaction – Teacher-Student Relationship Correlation

		Teacher-Student Relationships				Quality of Interactions		
		Conflict	**Closeness**	**Dependency**	**Total STRS**	**High**	**Moderate**	**Total Interaction**
Conflict	Pearson Correlation	1						
	Sig. (2-tailed)							
Closeness	Pearson Correlation	.567*	1					
	Sig. (2-tailed)	.018						
Dependency	Pearson Correlation	.600*	.187	1				
	Sig. (2-tailed)	.011	.473					
Total STRS	Pearson Correlation	.814**	.935**	.447	1			
	Sig. (2-tailed)	.000	.000	.072				
High	Pearson Correlation	.351	.451	.470	.496*	1		
	Sig. (2-tailed)	.167	.069	.057	.043			
Moderate	Pearson Correlation	.436	.509*	.293	.547*	.818**	1	
	Sig. (2-tailed)	.080	.037	.255	.023	.000		
Total Interaction	Pearson Correlation	.425	.511*	.367	.553*	.917**	.980**	1
	Sig. (2-tailed)	.089	.036	.148	.021	.000	.000	

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

correlations between the students` conceptual science understanding scores and the nature of interaction ($r = .160$, $p > .05$). Similarly, the two dimensions of the quality of interaction did not show any significant correlation with the students' conceptual understanding of science.

The correlation between teacher-child relationship and students' conceptual understanding of science was investigated and Pearson Product Moment Correlations were computed. Students were rated by their teachers using the STRS in order to obtain teacher child relationship scores. Analyses of the data revealed that there was no significant correlation between the students' conceptual understanding of science and teacher-child relationship total STRS score ($r = .297$, $p > .05$). Similar results were observed for all three STRS subscales (closeness, dependency, and conflict).

There was a significant correlation between teacher-student relationships and teacher-student interactions ($r = .553$, $p < .05$). It appears that classroom conversations mostly occurred between the teacher and the students with whom the teacher perceived she had better relationships. Positive (e.g., positive comment, clarifying) and neutral interactions (e.g., directive comments, restating) represented most of the teacher-student interactions during the instruction. Both positive ($r = .491$, $p < .05$) and neutral interactions ($r = .514$, $p < .05$) were related to the teacher's perceptions of her relationships with the students.

Discussion

Children's learning and intellectual functioning both and in and out of the classroom is strongly related to the social interaction and relationships in which they are embedded (Cazden, 2001). Research on student learning and achievement suggests that social interaction in general, and classroom interaction, has significant effects on children's learning and cognitive development (Mercer & Littleton, 2007). Elementary school children spend most of their time at school in one classroom, interacting with their teachers and with their peers. Thus, enhancing the quality of their interactions and relationships with their teachers could provide the means for creating a positive classroom environment, and a more desirable social atmosphere that is necessary for increased student motivation and interest in learning. Teachers are expected to establish positive relationships with their students in order to obtain better student outcomes. Teacher-student interactions and classroom talk provide opportunities for teachers to learn more about their students, as well as facilitating positive and supportive classroom interactions. In turn, this positive social context can lead to improved academic outcomes. Research suggests that students with positive, caring and quality relationships with their teachers experience fewer problems at school, and put more effort toward meeting their teachers' expectations (Baker, 2017; Hamre & Pianta, 2001).

The findings provide empirical evidence that the teacher utilized classroom talk in several ways to create a learning environment that generated student interest and engagement in science. Twelve types of teacher-student interaction categories that were used to investigate classroom talk during the science lessons successfully captured all verbal interactions that the teacher used to diagnose student understanding, explore and extend student ideas, clarify comments, provide feedback, express approval or dissatisfaction, request certain behavior, establish rules, express frustration, and provide additional help. The nature of the teacher-student interactions during the science lesson appeared to be more neutral and positive than negative, and the quality of the teacher-student interactions were more moderate rather than high in quality. The classroom teacher devoted limited time for high quality teacher-student interactions such as; open-ended questions, clarifying comments, scaffolding and individual interaction. The teacher seemed to create a balance between the time she could devote to the high demanding classroom activities and meeting the objectives of the lesson and the goals of the curriculum. Structuring open-ended questions to initiate higher-order thinking and engaging the students in high demanding tasks and providing them individual help as needed may not always be possible for the teacher. The results of the study revealed that the teacher utilized classroom talk in several ways to generate student interest to the topic, and to provide opportunities for students to share their ideas.

The findings suggested that there was a significant correlation between teacher-student relationships and teacher-student interactions in the classroom ($r=.553$, $p<.05$). It appears that classroom conversations mostly took place between the teacher and the students with whom the teacher had a positive relationship. Positive (e.g., positive comment, clarifying) and neutral interactions (e.g., directive comments, restating) represented most of the teacher-student interactions during the instruction. Both positive ($r=.491$, $p<.05$) and neutral interactions ($r=.514$, $p<.05$) had a significant correlation with the teacher's perceptions of her relationships with the students. However, the teacher seemed to engage in negative interactions with the students whenever she felt it was necessary, regardless of her overall relationship with a particular student.

There was no significant correlation between the teacher-student relationships and negative teacher-student interactions ($r=.359$, $p>.05$). It appeared that teacher-student relationship played a significant role in students' interactions with their teacher, and their level of participation during the lessons. This might be related to the comfort level of the students when interacting with their teacher as it also could be related to their self-esteem. The teacher committing herself to listening to what each student has to say and acknowledging the importance of their ideas played a significant role in teacher-student interactions. It appeared that students with a positive relationship with their teacher took more part in classroom conversations. This is consistent with research by Hamre and Pianta (2001) who noted that those students who have positive relationships with their teacher show more confidence in exploring the limits of their learning environment both academically and socially. They are more eager to deal with academic challenges and to discover new information.

The closeness of the teacher-student relationship seemed to be the most important factor affecting the overall number of teacher-student interactions in the classroom ($r=.511$, $p<.05$). The teacher having a close relationship with a student appeared to impact the student's willingness to take part in classroom discussions. Teacher-student relationships played a vital role in students' readiness to share their ideas. Interestingly, the closeness of the teacher-student relationships did not necessarily warrant positive teacher-student interactions. On the contrary, the students who had closer relationships with their teacher and participated more in the classroom talk were also involved in more negative interactions than their counterparts ($r=.493$, $p<.05$). Limiting the number of interactions with those students who feel more comfortable in the classroom talk and keeping them under control seemed to be the main concern of the teacher. The findings also provided evidence that positive teacher-student interactions were significantly correlated with dependency ($r=.521$, $p<.05$), and student's over-reliance on the support of the teacher was supported by positive teacher-student interactions.

The quality of the teacher-student interactions during science lessons is important as it relates to improved student learning. The findings suggested that there is a strong relationship between the teacher's perception of her relationships with the students and the quality of teacher-student interactions in the classroom. The current study approached the quality of the interaction types by identifying two dimensions; moderate and high-quality interactions. Both moderate ($r=.547$, $p<.05$) and high quality ($r=.496$, $p<.05$) teacher-student interactions were significantly correlated with the teacher-student relationships. The observations of moderate and high-quality interactions tended to increase as the teacher's perception of her relationships with the student improved. Most of the interactions in the classroom were observed to be more moderate quality than high quality. The teacher seemed to engage in moderate quality interactions (e.g., closed questions, restating) more often with those students with whom she had closer relationships ($r=.496$, $p<.05$). Such closer relationships allowed her to manage the pace of the instruction efficiently. It was evident from the observations that positive teacher-student relationships did not necessarily warrant for high quality teacher-student interactions in the classroom. The teacher had limited time to teach the lesson, and this seemed to have prevented her from engaging in high quality interactions with the children. Engaging in high quality interactions (e.g., scaffolding questions, clarifying) requires the teacher to spend more time revealing students' underlying thoughts and providing appropriate support. The teacher seemed to be concerned with the efficient use of class time in order to adequately address all of the relevant science topics. Thus, it resulted in fewer opportunities for the students to engage in high quality interactions with their teacher. On the other hand, the teacher was observed to be engaging in high quality interactions when there was an expectation for the students to think critically. Such attempts at improving students' reasoning required the efficient use of class time wisely while providing in-depth explanations and clarifications for correcting any student misunderstandings.

Students' conceptual understanding of science was measured by administering pre- and post-tests at the beginning and at the end of the science unit on the solar system. The findings revealed that students' conceptual understanding related to the specific science unit improved during the science lessons. The findings did not suggest any significant relationship between the nature of teacher-student interactions in the classroom and the student's conceptual understanding of science. Students' improvement in conceptual understanding did not relate to their one-to-one interactions with the teacher, but they seem to have benefited from the classroom instruction as a whole. The three dimensions of the nature of interactions (positive, negative, neutral) also did not show any significant correlation with the student's conceptual understanding of science. Similar results were also observed for the quality of interactions category and its two dimensions; moderate and high-quality teacher-student interactions.

The results revealed that students improved their conceptual understanding of the topic during the science unit. However, it was not significantly correlated to the teacher-student relationships as perceived by the teacher. This may be due to the effort the teacher devoted to creating a rich learning atmosphere that was productive for all the students, and not just for those who had a positive relationship with the teacher. Wubbels and Levy (1993), rightfully emphasize the importance of teachers' behaviors in the learning environment as it strongly relates to the student's interests towards learning. The findings suggested that regardless of their teacher's perception of the relationship as close, dependent or conflictual, the students did not seem to notice or experience any negative behaviors from their teacher that would hinder their learning and interest in science. The teacher seemed to be successful in creating a supportive learning environment where all students experienced the joy of learning as they participated in classroom activities and discussions. The teacher was able establish an open learning atmosphere that moved each of her students' conceptual understanding of science to a higher degree and provided support for generating student's interest in science.

The current study contributes to prior research and supports the importance of a friendly classroom environment for student engagement and learning. A learning environment that is rich in social interactions and student participation allows students to construct their own conceptual understanding of science. All students in the classroom potentially benefit from actively participating in the learning process while reflecting on each other's ideas and experiences. ■

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