UNIVERSITY OF CALIFORNIA, SAN DIEGO

# Empathy in Inquiry:
# Supporting Middle School Science Students in Developing Empathy Through Group Reflections During Guided Inquiry

A Thesis submitted in partial satisfaction of the requirements
for the degree Master of Arts

in

Teaching and Learning (Curriculum Design)

by

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The Thesis of Samantha Brooke Greenstein is approved and it is acceptable in quality and form for publication on microfilm and electronically.

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University of California, San Diego

2010

# DEDICATION

This work is dedicated to the 1988 Los Angeles Dodgers who, at the age of five, taught me that hard work and dedication leads to great things. Oh, and it is dedicated to my parents even though they didn't let me stay up to see the Dodgers win the final game of the world series that year.

# EPIGRAPH

The young must remember that all good and worthwhile things take time (and that is exactly as it should be). Their elders must remember that although not all change is progress, all progress is the result of change (and to resist or fear change is often to get in the way of progress).

*Coach John Wooden*
(1910 – 2010)

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ABSTRACT OF THE THESIS

Empathy in Inquiry:
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by

Samantha Brooke Greenstein

Master of Arts in Teaching and Learning (Curriculum Design)

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Christopher P. Halter, Chair

Most recent research on science education finds that inquiry-based learning in the middle-school science classroom is the most effective method in preparing students to think critically about scientific concepts. While research has demonstrated the beneficial effects on conceptual understanding for students who learn through inquiry-based methods of instruction at the middle school level, not much research has been done on how inquiry-based learning affects students' empathy, or students' ability to identify with and understand the situation, feelings, and motives of their peers. This research investigates how inquiry based learning can be used to increase students' understanding of what their peers think, why their peers have the views that they do and how these understandings contribute to science learning. The students participating in this study took part in a curriculum entitled *What's Your Idea?* where they reflected on group processes during a guided inquiry investigation. Participating students generally increased their empathy towards their peers and were likely to use the ideas of their peers during the investigation. This finding implies that inquiry-based learning provides benefits other than conceptual understandings for middle school students.

# CHAPTER I. INTRODUCTION

An eighth grade young man in a physical science class that I teach at Surf Street Middle School in the Ocean Boulevard Union High School District was asked why he chooses to work with the peers he does in his science class. Neal, a high-achieving student who resides in an affluent San Diego County neighborhood responded, "because they are my friends and I feel that being intellectually superior to them makes me feel like a big fish, even in such a small pond, never the less, I work with them mainly because they are nice." This young man is considered by many teachers to be one of their top students. The math class he is taking this year is typically a ninth grade course that only the top math students are eligible to take. Last year Neal won the seventh grade English award and earned high marks in all of his classes. By most teachers', administrators', and community members' accounts, Neal would be considered to be a model student. Neal's abilities to interpret and apply information are above the abilities of typical thirteen year olds, but these skills are not the only skills that are valued in the world. Having empathy for and understanding the perspectives of others are essential for people to have in order to effectively work in collaborative settings. If schools focus only on content knowledge, students will not develop many of the skills that are likely to lead to success.

Our world is facing increasingly complex problems that threaten our very existence. Currently, a failing American economy is lowering the standard of living for millions of people; cultural and socioeconomic inequalities are leading to a large achievement gap; and war and terrorism claim the lives of thousands of people every year. While current world leaders are struggling to find solutions to these problems, as well as many others, we must train our next generation of leaders in the communication and problem-solving skills that will help them to be more successful in finding solutions. These skills need to be taught early in the lives of our students and must be taught in such a way that students are empathetic to others and are able to understand the perspectives of those who have differing views.

## Scientists as Group Members

The scientific community consists of the total body of scientists, including those employed by organizations that focus on science issues and those who are affiliated with science departments or programs at educational institutions. This community also consists of the relationships and interactions these scientists have with each other. By using the scientific method, scientists are expected to achieve objectivity in their findings. Peer review and thorough debate within journals and at conferences are considered to be extremely important in ensuring objectivity in scientific findings. Such objectivity in turn ensures that any finding can be reproduced by any other scientist and then can be accepted by the scientific community as a whole. Scientists work as group members to maintain the quality of research methodology and interpretation of results.

## Middle-School Students as Group Members

Teachers and schools use a variety of ways to group students for instruction. This is often the case in middle school science classrooms where lab supplies are limited and students are required to work in groups so that everyone is able to complete lab activities. While research exists regarding the effects of grouping students in different ways so that they can be successful in the classroom, little research exists on how grouping students changes their perspectives on other group members.

# CHAPTER II. ASSESSMENT OF NEED

Middle schools across the nation serve students between the ages of 10 and 14. These students are in the preadolescent stage of development, which is marked by a specific period of cognitive and social development that effects how students act in the social and academic settings found in schools. As discussed later in this section, the typical middle school student is developing the ability for metacognitive thinking while trying to form a single identity and gain a better understanding of who he or she is. As students form their own identity, they often encounter insecurities both within themselves and from other students. These insecurities commonly lead to bullying and alienation among students in the middle school grades (Novick, 2010).

## Social Development in Middle School

Erikson (1963) defines the preadolescent stage of development, which occurs between the stages of childhood and adolescence, as a transitional space between the childhood striving for competence and the adolescent formation of an independent and cohesive identity. Most students in this age group are transitioning from the childhood question of whether they are able to be productive human beings who are capable of being successful at school, to the adolescent work of refining a sense of self by testing roles and then integrating them to form a single identity. If students are unable to do this, they become confused about who they are. The transition into the adolescent stage of development usually causes students to have a greater sensitivity to the differences between self and peers. This finding affects the teaching and learning of middle school students because the social developmental issues that these students encounter interfere with their ability to focus on the academic content in the classroom. Knowing what children at each age are developmentally capable of doing physically, socially, emotionally, and cognitively enables respectful, successful teaching of all children (Wood, 2007).

**Cognitive Development in Middle School**

During the preadolescent stage of development, students' social development has an effect on their cognitive development. Students in this stage become capable of being metacognitive, or thinking about their own thinking, while also developing their theory of mind or the ability to think about other people's thinking (Kohlberg, 1984). During the preadolescent stage of development, typically developing students begin imagining what other people are thinking about them. As students in the preadolescent stage of development continue to develop their ability to reason, their social awareness and moral judgment also change. Many students in the preadolescent stage of development begin to criticize their society, their parents, and even their own shortcomings (Kohlberg, 1984). This increased need for and awareness of social status and acceptance by others often results in students feeling disconnected from and unaccepted by their school and peers.

**Cognitive and Social Issues in Middle School**

In a recent report entitled the *Healthy Kids Survey*, 7.5 percent of California students reported being harassed while at school. This translates to over 200,000 middle school and high school students harassed every year because of their race, ethnicity, religion, gender, sexual orientation, or disability (California Department of Education, 2003). Students harassed in schools are more than three times as likely to carry a weapon to school, to seriously consider suicide, to make a plan for attempting suicide or to miss at least one day of school in the last 30 days because they felt unsafe. Students who are harassed are more than twice as likely to report depression (feeling so sad and hopeless they stopped normal activities for two weeks), to use methamphetamines or inhalants and are more likely to have low grades (Cs or below), to be victims of violence, to smoke cigarettes, drink alcohol, binge drink, or use marijuana (CDE, 2003).

**Harassment and Achievement**

Test scores give a clear indication that students who are in groups that are commonly harassed in school have lower achievement levels compared to students who are harassed less frequently. On the national level, 83% of White eighth grade students scored at or above the proficient level while only 4% of Black eighth grade students and 6% of eighth grade Latino students scored at this level in science (NAEP, 2005). In the state of California, 32% of White students scored at or above the proficient level in science while only 6% of Black and 7% of Latino students scored at this level (NAEP).

**Local Cognitive and Social Issues in Middle School**

In 2008 the California Department of Education reported that only 33% of seventh graders in the Ocean Boulevard Union High School District reported in a survey that they felt “very safe” at school. This low number may be partly attributed to the finding that 26% of seventh graders in the Ocean Boulevard Union High School District reported being harassed on school property during the past year. These students reported feeling vulnerable, isolated, and afraid. Students who do not feel safe at school are at a higher risk to take part in behaviors such as drug use. Students reported feeling harassed because of their race, ethnicity, religion, gender, sexual orientation, or disability.

Ethnicity and disability are common reasons why students reported being harassed. 2009 STAR test results for Surf Street Middle School and the Ocean Boulevard Union High School District indicate that students in groups that are commonly harassed score lower than their peers. While 87% of eighth grade students at Surf Street Middle School scored at or above the proficient level on the Forces and Motion standards on the STAR test, only 61% of English Language Learners and 75% of students who have been diagnosed with a disability scored at this level. In the Ocean Boulevard Union High School District, 80% of eighth grade students scored at or above the proficient level on the Forces and Motion standards on the STAR test, but only 58% of English Language Learners and 63% of students who have been diagnosed with a disability scored at this level. While there are various reasons that contribute to the lower test scores for English Language Learners and students who have been diagnosed with a disability, students who are harassed by their peers feel alienated from school and this could affect academic performance. When all students are able to be empathetic towards their peers and to see the perspectives of these peers, the feelings of isolation and harassment will be lowered, allowing them the opportunity to increase their test scores.

**Research on the Effect of Social Issues in Middle School**

Juvonen and Wentzel (1996) found that academic and social developments are each inherently associated with learning and achievement. Juvonen and Wentzel (1996) found that in a sixth-to-eighth grade population, as students increased in their grade level, students felt there was an increasing emphasis on social comparisons among classmates. Students also felt as though teachers were more evaluative academically.

The main rationalization used by students who completed less schoolwork was that they "felt stupid" (Juvonen and Wentzel (1996). The alienation that students feel at their school leads to less engagement in the classroom community and lower academic achievement (Jonkmann, 2009).

According so the National Assessment of Educational Progress (NAEP) data, students who identify as being part of minority groups, including Latino and Black subgroups, perform at a lower academic level than their non-minority peers (NAEP, 2005). While there are a variety of reasons that can explain the differences in academic achievement between minority and nonminority students, Brobeck (2006) found that when either teachers or students view their peers as inferior academically and intellectually, it increases the chances of these students having lower academic performance. Brobeck found that nonminority teachers and students were more likely to view students of minority status as inferior than students of nonminority status.

Students who have a lower level of achievement are less likely to be seen as valuable to their higher-achieving peers. Lease, Kennedy, and Axelrod (2002) found that students who were socially dominant in the classroom were perceived to be bright by their peers and teachers. The authors also reported that students who were socially dominant at the middle-school level often exhibited excluding behaviors such as bullying. High levels of shyness and withdrawal characterize most students who are socially rejected at the middle school level. These behaviors almost always lead to lower participation by students in the classroom (French, 1988).

Vygotsky held that life experiences affect and influence development. The use of language determines learning and learning determines the use of language

(Vygotsky, 1934). The decreased participation of socially rejected students means that not only will these students be less likely to contribute to the understandings of their peers, but these students are also less likely to develop intellectually because of their limited use of language and interactions with others. Students who have a variety of life experiences and interact and use language with a large amount of people will have more opportunities to develop intellectually. If all students are encouraged to use language in a safe and secure environment, they will be more likely to develop intellectually.

Students who perform at a lower academic level are less likely to be seen as valuable in academic settings by their peers. In the preadolescent stage of development, when students are beginning to understand their peers' thinking, students become more aware of the conceptual understandings of their peers. This can have social consequences for students who are not able to express their conceptual understandings as easily as their peers. For example, English Language Learners are expected to keep up with increasingly complex curriculum without the opportunity to develop academic language through participation. In addition, students who have been diagnosed with a learning disability often take longer to process and express their ideas. These two groups may be considered by their peers to have lower conceptual understandings because they are not able to quickly or efficiently put their thoughts into the English language.

Ryan and Patrick (2001) found that students' perception of being in a classroom where the teacher encouraged classmates to respect the ideas of others and not to laugh or make fun of them led to less anxiety for students and led to a higher cognitive engagement. They also found that students' perception of being encouraged to interact with others in the classroom and to share their ideas increased their motivation and engagement. However, they also found that although students interacted with their peers more, they did not show an increased confidence in doing so. This finding shows that an increased feeling of social safety in the classroom benefits all students but that there must be additional factors that come into play as well.

Factors outside of the classroom are likely contributors to the feelings of social rejection that lead to decreased achievement levels. It is important to find educational approaches that increase the ability of all students to contribute to the understandings of their peers on both academic and sociocultural levels. In a science classroom in which students work in lab groups, the interaction and collaboration students have with their peers can help students develop their understanding of the ideas and perspectives of their peers. If all students feel that their ideas are valued and that they can benefit from the ideas of other students, these students will be more likely to be empathetic to and understand the differing perspectives that people have when solving problems and this would lead to an increase in students confidence and academic success in the classroom.

## Conclusion of Assessment of Need

Middle school aged students are facing a variety of social and cognitive issues that have the potential to negatively impact their academic achievement. Students attending middle school are often trying to figure out their place in the community of their peers. While students are attempting to establish their identity within a group, students gain reputations with their peers that may devalue the ideas students bring to their groups in a classroom setting. Because students are often focused on the social issues that they face, many of them are unable to fully develop their academic understandings. In order for students to be prepared to face the complex issues that our world faces, students must be able to openly share their ideas and astutely listen to the ideas of their peers. Students will be unable to do this if they do not see all of their peers as equally capable of thinking intellectually.

# CHAPTER III. LITERATURE REVIEW

In order to assist students in becoming more empathetic towards their peers, teachers must have an understanding of three main educational constructs. These constructs are: understanding, social justice, and inquiry-based learning. In considering these constructs, teachers must first understand what empathy is and then they must understand the sociocultural learning theories that explain how peers in the classroom affect other students, particularly in an inquiry-based classroom.

## Understanding

Conceptual science understanding in a middle school science classroom consists of more than merely memorizing facts and answering predetermined questions. Students do not enter the classroom as blank slates, but come in with an abundance of information from past experiences. Students also enter with a great deal of both correct and incorrect preconceptions (Driver, 1986). While students can learn a great deal from their past experiences and from addressing the misconceptions they bring into the classroom, they can also enhance their conceptual understandings by considering the experiences and misconceptions of their peers. In order to do this, teachers need to establish safe intergroup relations within the classroom. Unfortunately, social issues affect these intergroup dynamics, which then affect the understandings students are able to achieve in the classroom.

### Facets of Understanding

Wiggins and McTighe (2006) theorize that there are at least six different facets of understanding. In order for people to truly understand, they should be able to explain, interpret, apply, have perspective, empathize, and have self-knowledge. If students have all six of these facets of understanding in regards to a certain topic, they are considered to have a complete and mature understanding of that topic (Wiggins & McTighe, 2006).

In order to have empathy, or the intellectual identification with or vicarious experiencing of the feelings, thoughts, or attitudes of another, students must be able to grasp the responses and reactions of others and must try to understand another person, people, or culture (Wiggins and McTighe, 2006). In a middle school science classroom, it is important for students to develop the understandings of perspective and empathy because the ability of students to develop these understandings will enable them to have a more complete view of the world around them. Students who have an understanding of these facets will understand the beliefs and values of those with whom they may disagree. In a middle school science classroom, since all students come in with prior knowledge, students need to learn how to understand and empathize with the perspectives that their peers have in order to gain knowledge from the prior knowledge their peers have. As discussed in the introduction, in order to be a part of the scientific community, people must interact with their colleagues in a manner that requires them to share their ideas while learning from the ideas of their peers. These interactions are also essential to the middles school science classroom.

**Cognitive Understanding**

People construct new knowledge and understandings based on what they already know and believe (Bransford, 2000). People come into all situations with prior knowledge that considerably influences what they notice about situations and how they organize and interpret the world around them. Since the ability to gain new knowledge is affected by incomplete understandings and misconceptions, it is sometimes not realized that understanding or misunderstanding of new information has occurred. For conceptual understanding, pre-existing knowledge should be built on in ways that allow students to have a more refined understanding of new knowledge. (Bransford, 2000). In order to build a bridge between what students know about a topic and what they need to learn about it, a teacher must take the cultural and linguistic background of each student into consideration (Villegas & Lucas, 2007). Valuing students' prior knowledge allows students the opportunity to connect what they are learning to what they already know which will help them succeed in the learning process (Bourdieu, 1973). The cultural capital, or the forms of knowledge, skills, education, and advantages that students bring to the classroom influences their ability to understand conceptual ideas in science. Therefore, it is important for teachers to understand how sociocultural aspects affect intergroup dynamics.

**Sociocultural Learning**

Not all students have the same prior knowledge, so there are differences in the learning of students because students perceive information differently based on what they already know (Vygotsky, 1997). A person's culture affects her or his perception and processing of information. When a person learns, the meaning of the information comes from how the person interprets it. This interpretation is constructed through the context in which the information is given. The beliefs, customs, practices, and social behavior of a person will influence the meaning of the information that they learn.

***Community of Learners.*** In a community of learners (Lave and Wenger, 1991) other members of the community influence the interpretation of material, so the culture of each member of the community influences all other members. When the members of the community use language to express their thoughts, this language adds to the understanding of both the person who used the language and every other member of the community. When people share a socio-cultural background, they are more likely to share the local and contextual meanings of their language, which is related to their age, gender, and social and economic status. While it is easier for them to talk about and experience new understandings with those who come from similar socio-cultural backgrounds, students need to learn how to benefit from the knowledge of those from other sociocultural backgrounds (Vygotsky, 1980). By developing empathy and perspective, students will be more receptive to others' ideas because they will realize that differing perspectives do not threaten their own ideas but only serve to strengthen those ideas.

***Intersubjectivity.*** There are obstacles to creating intersubjectivity for all students in a middle school science classroom. Students have well-established reputations with their peers and have a varying degree of value with these peers that have already been established based on their social and academic reputations. Cole (1990) argues that the social behaviors and social competence of students, or their ability to function successfully in a social situation, influences the degree to which their peers accept them. Social competence includes the social, emotional, and cognitive skills and behaviors needed to adapt to social situations (Cole, 1990). Students who are good students are often looked to by their peers as having value in an academic setting while those students who struggle are seen to have either no value or value that is not useful in an academic setting. Socially, these students may be accepted because they have traits that are accepted in non-academic settings so they may be accepted by their peers while still being viewed as academically inept (Jensen-Campbell et al., 2002). These social issues prevent students from interacting with all of their peers and inhibit the ability of students to learn from the ideas, beliefs, and past experiences of their peers. Middle-school students are often unable to grasp the importance that information from outside of the classroom has on their conceptual understandings of content. So many of them reject this notion that students who are not academically high achieving are the only ones who can contribute to their understanding (Cole, 1990).

When students' prior knowledge from outside the classroom is drawn upon in the classroom and integrated in science, students develop a sustained interest in science. This interest is evidenced by a self-motivation to take part in science outside of the classroom. Students who are self-motivated to use science outside of the classroom are found to use science to expand their exploration of science activities (Basu and Calbrese Barton, 2005). When students see how a topic relates to their lives in one way, they begin to ask new questions that they want answered. For example, when students learn about chemical reactions, they want to clarify what reactions they have seen in their lives and how they can use chemical reactions. If students realize that their peers, especially peers from a different sociocultural background, have experiences that can also help shape the science learning environment, then they will be more able to find way to connect new information to their prior knowledge. If all students in a classroom can reach intersubjectivity then students will be able to learn and grow from more people than just those who share the same sociocultural background.

**Social Justice**

It is widely acknowledged that most standardized tests are tests of general achievement. These tests reflect broad ways of thinking and problem solving that are rooted in the dominant culture (Harry and Klinger, 2007). Often, students who do not score well on these tests are labeled as failures by both teachers and peers and are not seen as having any educational value to their peers. High-achieving students are under the impression that they can only learn from other students who are high-achieving. They disregard lower-achieving students because they have not proven to have an understanding of the information that is valued in our schools (Cole, 1990).

Most White students are not raised with the understanding that substantial privileges come with being a White person in America. Perhaps more directly experienced is that these privileges are gained because of something as superficial as skin color (Michie, 2007). Oftentimes a conflict exists within students who do not share the socioeconomic cultures of a majority of their peers. If students are to experience success, they and the school must work to resolve this conflict so that the norms of each student's home and community are valued (Banks, 2005). However, schools rarely take time to work towards meeting this goal because the challenge of doing this is that it is difficult for schools to integrate multiple norms into an institutional schooling system that operates under the hegemonic norms of a particular dominant culture.

Schooling prepares people for jobs that then determine the socioeconomic status of each person and this status usually leads to the amount of personal social power one possesses (Delpit, 2006). In other words, those who are in power are powerful because they were educated in a way that gave them the cultural capital necessary to be powerful in our society. Children from middle-class homes tend to do better in school than children from lower socioeconomic backgrounds because the culture of schools in our education system is based on the culture of the upper and middle classes (Delpit, 1988). Those who are at the top of the power structure direct the development of the schools of our society. There is little effort to include the needs of the children who are not represented by those in power. This lack of effort may be due to the inability of policy makers to have empathy or perspective for those who are not represented by those in power.

An important part of interrupting the effects of schools on the cycle of oppression that effects students who do not fit into the dominant culture is to ensure that students understand that they enter the classroom with preconceived notions about their peers (Tatum, 1997). Whether they are able to acknowledge it or not, students enter our education system with stereotypes and prejudices that affect the way they view other students. So do teachers. Oftentimes, the structure of our schools only serves to perpetuate and reinforce the cultural stereotypes that exist. When students come from different backgrounds, a teacher must establish a community of learners where all students value the backgrounds and prior knowledge of their peers. Otherwise, students who do not feel valued may become marginalized and are more likely to feel disconnected from their learning. When students are less engaged in the classroom community they have been found to have lower academic achievement (Jonkmann, 2009).

While most inquiry science curriculums focus on the development of a student's ability to explain, interpret, and apply information, they rarely provide opportunities to develop students' perspective or their ability to empathize (Youth Learn Initiative, 2003). Conceptual understanding is important but cannot be fully realized without social interactions with other people who have ideas, which must also be explicitly fostered with the classroom.

# CHAPTER IV. CURRICULUM REVIEW

Teaching and learning theory includes three constructs that support the development of students' empathy and perspective: the six facets of understanding (Wiggins and McTighe, 2006), the importance of building understanding on the prior knowledge of students (Bransford, 2000), and the sociocultural aspects of group interactions within the classroom (Vygotsky, 1980). The materials being reviewed in this section relate to inquiry-based science teaching and more traditional "direct-instruction" methods of teaching science.

## Inquiry-Based Learning

Inquiry-based learning is built on the core premise that learning should be based around students' questions. While there are multiple approaches to integrating inquiry in the classroom, the teacher's job in an inquiry-learning environment is to help students with the process of uncovering knowledge themselves. Teachers should be viewed as facilitators of learning, rather than the providers of explicit content knowledge to the students. Inquiry-based education has gained popularity in recent years, but there is debate about the effectiveness of this form of instruction (Center for Science, Mathematics, and Engineering Education, 2000).

### History of Inquiry-Based Learning

Inquiry-based learning was developed during the discovery learning movement of the 1960s. Many educators felt that inquiry methods were more successful than the traditional forms of instruction where students were required to memorize facts (Bruner, 1961). In inquiry learning students learn actively and address their misconceptions concerning the material. Their progress is assessed by how well they develop experimental and analytical skills. Less emphasis is placed on how much information students possess, while more emphasis is placed on the process of scientific understanding.

**Suchman's Model of Inquiry**

In Suchman's Inquiry Model (1961), three different types of inquiry are defined. The first type of inquiry is called "structured inquiry." In this type of inquiry students are given a problem to solve, a method for solving the problem, and necessary materials, but not the expected outcomes. Students are to discover a relationship and generalize from the data collected. The second type of inquiry, "guided inquiry," is an approach in which students must also figure out a method for solving the problem given. The third type of inquiry, and the type that most resembles how scientists work, is "open inquiry." In this type of inquiry, students must also formulate the problem they will investigate. While open inquiry most closely mimics the actions of scientists it is often the most difficult type of inquiry to implement in the classroom because it requires resources that are often difficult to find in schools. These resources include the need for a low teacher-to-student ratio and access to a variety of supplies so that students can be supported in their individual or small-group research.

The three different types of inquiry are considered to be either inductive or deductive approaches to teaching inquiry. Inductive science activities take place when a teacher sets up learning activities that will guide students toward "discovering" a science concept or principle. Deductive science activities take place when a teacher presents a concept or principle to students and then gives students an opportunity to engage in activities to reinforce the concepts (Hassard, 2005). While "structured inquiry" is a form of deductive teaching, both "guided inquiry" and "open inquiry" are forms of inductive inquiry.

**Best Practices**

Zemelman's (2005) structures of "Best Practice Teaching" support the idea of open inquiry with a call for small-group activities and authentic experiences. In open-inquiry, students are expected to act like real scientists. People who work in the field of science rarely work in isolation. Group investigations are used so that students can understand and benefit from the prior knowledge of their peers. With group investigations, students are more likely to challenge the findings of their peers and come up with alternate solutions.

Zemelman (2005) further finds that authentic experiences are essential to student understanding. Authentic scientific inquiry, as supported by Suchman (1961), relies on the interest and natural curiosity of students. In inquiry, students become researchers while working collaboratively. Zemelman (2005) claims that it is difficult to engage students in authentic open-inquiry within the confines of school because school does not model the "real-world." He does, however, find that although it is difficult to make situations entirely authentic, if students immerse themselves in doing guided systematic inquiry it is easier for them to engage in open inquiry outside of the classroom.

**National Science Education Standards**

While inquiry-based learning is supported by the *National Science Education Standards* (1996) it is not always used in the classroom. More traditional science teaching methods expect students to master disconnected facts instead of working towards broader understandings, critical reasoning, and problem-solving skills. The emphasis is placed on students' abilities to answer fact-based questions similar to those found on standardized tests (Harms and Yager, 1981; Weiss, 1987). Students in inquiry-based learning environments are expected to devise experiments. In contrast, students in a more traditional setting conduct experiments within a predefined set of procedures where students are working towards expected outcomes. The goal in the more traditional form of instruction is to get to the "right" answer while in inquiry-based classrooms the goal is to work towards a better overall conceptual understanding while continuing to ask questions.

Students who participate in inquiry-based activities spend time making observations, manipulating materials, and conducting laboratory investigations. In one study, students of an inquiry curriculum were found to be developing cognitive abilities such as critical thinking and reasoning, as well as learning science content (Shymansky, 1983). Although these skills are essential for those who wish to be successful in the science community, not all researchers agree that inquiry learning should be implemented at the middle school level.

**Arguments Against Inquiry**

Krajacik et al. (1998), Jeong et al. (2004) both came to the conclusion that students at the middle school level had difficulty asking relevant scientific questions that are essential to inquiry learning. These researchers also concluded that students at the middle school level had problems deciphering between relevant and irrelevant data and had difficulty drawing conclusions based on the data that was collected. Students may experience difficulties in these areas because they are accustomed to being told what to do and which answers are correct (Trautmann et al., 2002). When students are not familiar with the inquiry process they may be intimidated and discouraged by this difficulty. This frustration of students along with a lack of support for teachers who implement the process can lead to a dismissal of the method by teachers (Krajacik et al., 1998). Kirschner (2006) argues that middle school students do not have high enough levels of prior knowledge to provide "internal" guidance necessary for inquiry. Although completing inquiry activities may be challenging for students, this is not a reason to get rid of inquiry-based activities. Although problem solving skills may not be fully developed in middle-school age students, these skills are important for students to develop in order for them to be successful in higher level classes and in many occupations. In order for these students to develop problem-solving and collaboration skills, they must practice them.

In a study of two middle school science classrooms, Millstone (2010) identified four models of guided-inquiry and looked at how the domains of teacher practices, physical structures of the classroom, and classroom systems such as routines and procedures influenced the quantity and quality of argumentation used by students. Millstone concluded with a model of how teachers can provide a context for successful inquiry by integrating these three components.

Research on science learning concludes that understanding science is more than knowing facts; rather, students build new knowledge and understanding from what they already know and believe. Indeed, students formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know (Bransford, 2000). This research collectively supports inquiry learning. Additionally, the social environment in which learners interact with others mediates learning

(Bransford, 2000). Students benefit from opportunities to discuss their ideas with others, to challenge each others' ideas, and to reconstruct their ideas throughout the process (Rosebery et al., 1992).

**Inquiry-Based Learning in Middle School**

Inquiry-based learning should help students overcome the social problems in middle school. An aspect that provides difficulty for both the teacher and the student is that in order for the inquiry method to be successful, the curriculum must be implemented in a risk-free environment (Wolf and Fraser, 2008). If a student does not feel emotionally safe in the classroom and does not feel free to communicate her or his thoughts and ideas, then the inquiry process will not work. In an inquiry-based classroom, teachers must effectively guide or expand student thought in order to ensure that students are working towards a better understanding (Wolf and Fraser, 2008). If students do not feel supported by their teachers and peers, or feel that they are being judged for what they say, they will be unlikely to discuss their thoughts within the classroom. This is why it is essential that students in a middle school science class feel that their peers and their teachers value their ideas.

The National Inquiry Standards (1996) state that middle school students should be able to recognize and analyze alternative explanations and predictions to scientific phenomena, an outcome that calls students to recognize and analyze the ideas of others. While students should eventually understand all sides of important topics that are debated in the scientific community, they can begin working towards developing the skills of recognizing and analyzing the ideas of their peers by working on their ability to empathize and gain perspective of their peers' ideas in the middle school classroom. If students develop these skills they will be better equipped to work with people who have different ideas and opinions in a respectful and diplomatic way. Respect and diplomacy are essential in behaviors in science because science is a field that relies on collaborative efforts that work towards answers. Without respect and diplomacy, people are unable to fully grow from the ideas of others.

While both the National Inquiry Standards (1996) and Wiggins and McTighe (2006) support a student's ability to understand differing perspectives, there is no support for this type of curriculum in the textbooks that have been approved by the state of California for middle school science classes (Glencoe, 2007; McDougal Littell, 2007; Pearson Prentice Hall, 2007). While these texts ask students to remember, interpret, apply, and explain, they are not asked to understand different perspectives or have empathy.

The California-adopted textbooks also have a very limited focus on inquiry in the classroom (Glencoe, 2007, Holt, 2007, McGraw-Hill, 2007, Pearson Prentice Hall, 2007). All of these texts provide supplemental materials that address inquiry learning, but inquiry learning is not the main focus of any of these texts. When looking at inquiry learning, these texts do not always share the definition of inquiry with the National Inquiry Standards (1996). For example, Prentice Hall's *California Focus on Physical Science* (2007) offers an Inquiry Skills Activity section in the teacher's edition that provides opportunities for students to observe, infer, predict, and classify. Students also practice the skills of posing questions and drawing conclusions, but are not given an opportunity to ask their own questions or draw conclusions that are not considered to be the "right" answer. Students need to use the processes of science and combine these with scientific knowledge to develop their understanding of science. Prentice Hall's textbook does not provide an opportunity for students to link their scientific knowledge with their inquiry skills nor does it provide any opportunities for students to develop their empathetic understanding.

The only California state approved text that largely uses inquiry-based approach is *Interactions in Physical Science: California Edition* (Herff Jones, 2007). While this text approaches physical science with an inquiry-based approach and provides team-building activities in its teacher resources, it does not provide explicit opportunities for students to reflect on the group process.

A review of approaches to teaching science in the middle school classroom reveals that while researchers and policy makers in the science field support inquiry-based learning, there are no available materials that specifically integrate the development of empathy and the ability to see different perspectives of students in an inquiry-based environment. However, approaches that take other aspects of inquiry-based learning into account, as researched by Wolf and Fraser (2008) have beneficial outcomes in students' understanding of the processes of inquiry. These results provide support for inquiry-based teaching that works to develop empathy and perspective in students.

This review brings me to a series of questions: How do middle school students interact with their group members in a classroom that implements a guided inquiry-based science curriculum while using group processing reflections? Sub-sets to this question include the following:

1. How do students relate to questions they have in the science classroom to their own lives?
2. What techniques do middle school students use to plan an investigation when working in groups of three to five students?
3. How do the ways students view their peers change after completing an inquiry investigation with those peers? How do the ways students view themselves change after completing an inquiry investigation with their peers?

# CHAPTER V. OVERVIEW OF THE *WHAT'S YOUR IDEA?* CURRICULUM

The *What's Your Idea?* curriculum focuses on using an inquiry-based approach to develop the ability of students to empathize with the beliefs of their peers. Students are encouraged to discuss their own ideas and past experiences with group members and to relate these ideas to the content in class. The objective is for students to apply the concepts they learn to both their own life experiences and the life experiences of their group members. Students reflect on how the ideas of their peers affect their own understanding of the content itself and its relevance to their own lives. Through the process of inquiry, students can discover how understanding science concepts, in this case concepts related to forces, increases their understanding about how forces work in their lives. Through this opportunity, students are able to learn from their peers in a setting that is supported by sociocultural learning theories (Vygotsky, 1997 and Lave & Wenger, 2001).

## Goals

*What's Your Idea?* curricular activities are designed to help students increasingly value the ideas of their peers as they learn new science concepts. This curriculum especially seeks to broaden the perspectives of science students when they find little academic value in the input of peers and to help them understand that these peers have ideas and experiences that can contribute to the learning of all students. Students who participate in the implementation of these activities will express a deeper connection to the classroom community and value the contributions of all students, including themselves. Students will see how the contributions of all classroom members can contribute to the learning and understanding of all other students. Three sub-goals help determine if the overall goal has been met.

**Goal 1: Students ask a question about force and relate the answer to their own lives outside the classroom.**

During the *What's Your Idea?* activities, students used their own past experiences and current ideas to ask a question about a concept related to forces. As a group, students planned an investigation to answer the question. Having completed the investigation they then individually answer the question, "How did the activity relate to your own life or something outside of the classroom?" To determine if this goal had been met, I read and coded students' responses. By evaluating students' post-implementation surveys, I determined if students related their answers to a past experience. If, after this process, it was not clear if students related the answer to their own lives outside the classroom, I conducted further student interviews.

**Goal 2: Students use their own ideas and the ideas of their peers to design an investigation.**

The second sub-goal of the *What's Your Idea?* curriculum is that students use their own ideas along with the ideas of their peers to design an experiment that will help them answer a group question, in this case about forces. Students wrote investigative procedures individually and then worked with their group to make one procedure that the entire group followed. By reading individual and group investigations, I was able to see if the ideas of every student were used in the final procedure. In their reflections after the activity, students wrote journal entries about which students' ideas were "good ideas." This helped me to determine which students' ideas were most valued while planning the investigation. The procedure students cite in their final lab write-up helped me to determine how students used inquiry skills to answer their question.

**Goal 3: Students reflect on their peers' ideas to increase empathy.**

The third sub-goal of the *What's Your Idea?* curricular activities is that students reflect on the ideas of their classmates in order to increase the empathy they have for peers. Throughout the implementation of this curriculum, students wrote reflections about how they view the roles and contributions of their group members and what idea was the best idea of the day and their rationale for the answers to both of these questions. Student reflections and student interactions, as determined through my observations, were compared to pre-implementation survey answers and previous interactions. The *What's Your Idea?* activities ensured that students feel more connected to the classroom community and feel as though all students, including themselves, can contribute to the learning and understanding of all other students. By reviewing pre- and post-implementation surveys, I determined whether students were more open to group members' ideas that they did not previously think had academic merit. This helped determine if the curriculum created a more socially just environment in the classroom.

## Guiding Constructs

### Inquiry-Based Learning

During the implementation of the *What's Your Idea?* curriculum, students participated in a variety of guided inquiry investigations in a group of three to five students. Guided inquiry occurs when students are given a problem but must come up with the method to solve that problem (Suchman, 1961). All group members are responsible for reflecting on their peers' ideas. During these activities, the intention was for students to increase their understanding of physical science by taking part in authentic experiences in which they acted as researchers and constructed their knowledge in a community of learners rather than individually (Zemelman, 2005).

Small-group activities and authentic experiences in which students were expected to act like real scientists are essential to best practices in the science classroom (Zemelman, 2005). The construct of inquiry in the classroom contributes to the learning of students because in the planned group investigation, students used the prior knowledge of their peers to further their own understanding. After students wrote journal entries explaining their initial ideas on their own, they shared their ideas with their group members and the group members then determined which ideas should be implemented during the inquiry activity.

**Understanding**

The goal of the *What's Your Idea?* curriculum is to support students as they acquire conceptual understandings of science content. In order to have a deep understanding of concepts, students must also have empathy for others (Wiggins and McTighe, 2006). While gaining knowledge from the ideas of their peers, students gained a better idea of how their peers view the world. Students also gained a deeper understanding of how people other than themselves understand science concepts.

The process of working with groups and listening to their peers' ideas and beliefs encouraged students to discover facets of understanding that are often overlooked in a traditional science curriculum, as demonstrated in previous research examined in chapter three of this paper. Through sharing of their ideas and analyzing the ideas of their peers, students worked towards an understanding of the perspectives students bring into the classroom so they will be able to see others' ideas from a more impartial and objective stance (Wiggins and McTighe, 2006). Discussions with peers allowed students the opportunity to develop empathy by working to grasp others' responses and reactions to science concepts (Wiggins and McTighe, 2006).

Students worked toward a better understanding of science concepts by building from their prior knowledge. People construct new knowledge and understandings based on what they already know and believe and each person perceives information differently based on what he or she already knows (Bransford, 2000). Through discussions with their group members, students gained an understanding of the concepts by both relating their own experiences to the content and by listening to their peers' experiences and ideas. Using both their own experiences and their group members' experiences, students planned an inquiry investigation that answered a question they found important.

**Social Justice**

The activities in the *What's Your Idea*? curriculum support the construct of social justice. Students entered the classroom with preconceived notions about their peers (Tatum, 1997). All students, regardless of how they are performing academically in the class, have the opportunity to come up with ideas and share these ideas with their group members. Because all students contributed ideas and influenced the inquiry investigation, all students had value in the academic classroom community. If students feel as though they have academic value, they will be more likely to be engaged in the classroom which often leads to increased academic achievement (Jonkmann, 2009). Students who do not have confidence in their own academic abilities may be hesitant to share their ideas. The process of journaling initial ideas and then requiring all group members to listen to the ideas of others, and take notes on the ideas they find interesting, is designed to give students the opportunity to share their ideas in a low-risk setting.

The *What's Your Idea?* curriculum changes academic communication in an inquiry-based middle school science classroom. Students worked with groups of heterogeneous achievement levels. All students had the opportunity and forum to discuss their ideas, assumptions, and misconceptions in a low-risk small-group setting. Delpit (1988) found it essential that all students feel they have a voice within the classroom, particularly for underrepresented students. A low-risk and small-group setting helps to provide such a forum for all students (Wolf & Fraser, 2008).

This curriculum is designed to facilitate a community of learners (Lave & Wenger, 1991) in a way that encourages and requires each individual student to learn from his or her peers' prior knowledge. All students have some knowledge about physical forces because they experience forces on an everyday basis both by taking part in physical activities and by making observations about natural phenomena around them. Students' life experiences contribute to the way they view the world so each experience contributes to the culture of students. Since other members in a community of learners influence the interpretation of material, the cultural experience of each member of the community influences all other members. By working collaboratively in small groups, students have the opportunity to gain knowledge from many people.

According to Bransford (2000), people may not realize that they are failing to understand new information, so students need others to facilitate their understandings when they are gaining new knowledge. Each member of the community interprets the information differently because all students have different life experiences. In a community of learners, students can have their ideas challenged by their peers and can gain a better understanding of the information because in defending their arguments they will need to refine those arguments with evidence. During the implementation of this curriculum, students used the ideas of their peers to help them inquire into the scientific world. In order to do this, students reached intersubjectivity in that they shared common definitions of the material with their peers. By sharing and coming to a common understanding of past and current experiences, students began to view concepts similarly. If students were able to reach intersubjectivity, as discussed in chapter three, they were able to learn and grow from a broader community as opposed to drawing only upon those who share similar cultural backgrounds (Cole, 1990).

Table 1 summarizes the research goals of the *What's Your Idea?* curriculum and describes the activities that students will complete to support the educational constructs. Finally, Table 1 describes the evaluation plan that I used to determine if the research goals were met.

**Table 1: Implementation Overview**

| Research Goals | Educational Constructs | Activities | Evaluation Plan |
|---|---|---|---|
| Goal #1: Students ask a question about force and then relate the answer to something relevant to their own lives outside the classroom. | Inquiry<br><br>Understanding | Students will journal ideas about how the answers they find relate to experiences they have had related to forces and motion. | Students will complete pre and post surveys that will ask them to share ideas in regards to forces and about how they see themselves as scientists. |
| Goal #2: Students use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces. | Inquiry<br><br>Understanding | Students will journal a procedure and will use ideas of their peers to design a procedure as a group. | Students will complete a planning sheet that will ask them to share ideas about how to complete the experiment and will edit their plan after input from their group members. |
| Goal #3: Students reflect on their peers' ideas to increase their empathy. | Social Justice<br><br>Understanding | Students will journal their views on the strengths of their group members after working with their group on investigative procedures. | Students will complete pre and post surveys asking them to identify who they prefer to work with in the group and why.<br><br>Students will reflect on the roles and strengths of each group member and themselves. |

# CHAPTER VI. IMPLEMENTATION AND REVISION OF THE *WHAT'S YOUR IDEA?* CURRICULUM

The *What's Your Idea?* curriculum was implemented during a unit involving the force and motion state standards for California eighth graders. The content used during the implementation was taken from standards one and two of the California state eighth grade physical science standards (California Department of Education, 1998) (Appendix). The unit took place over a three-week time period with five eighth grade classes. These classes had a total enrollment of 160 students. Table 2 summarizes the national, state, and inquiry standards covered in the *What's Your Idea?* curriculum.

## School Environment Where Curriculum Was Implemented

The *What's Your Idea?* curriculum was implemented at Surf Street Middle School which is a member of the Ocean Boulevard School District.

### Ocean Boulevard School District

The Ocean Boulevard School District serves 12,458 students in four middle schools (including Surf Street Middle School), four traditional high schools, a continuation high school, an alternative high school, and an independent study high school. White students make up 72% of students, 13% are Asian, and 12% are Latino. The remaining 3% come from other ethnic backgrounds. English language learners make up 5% of the student population and 7% of students in the district qualify for free or reduced-price lunch.

### Surf Street Middle School

Surf Street Middle School, a 2009 California Distinguished School, is a public school serving 680 seventh and eighth grade students in San Diego County. Surf Street

Middle School serves students from diverse economic backgrounds. The students who attend Surf Street Middle School include not only students who reside in one of the most affluent areas in the state of California, but also students from a community that formed when migrant workers from Mexico came to California to work. Many of these workers resided in a small, socioeconomically disadvantaged community and worked on the land of those in the more affluent area. For this reason, Surf Street Middle School serves students from lower, middle, and upper class homes.

All of the teachers at Surf Street Middle School have a full credential and teachers have an average of ten years of teaching experience. All of the teachers are assigned to teach subjects for which they have a credential. This means that all teachers have been trained to teach students in the content area that they are actually teaching. The average class size at Surf Street Middle School is 29 students. White students make up 79% of the student population while 11% are Latino and 8% are Asian. Students of other ethnicities including African American and American Indian students make up 2% of students from Surf Street Middle School. At Surf Street Middle School, 9% of students participate in the free or reduced-price lunch program and 6% of students are English language learners. Currently, all English language learners at Surf Street Middle School come from Spanish-speaking homes.

**Table 2: California and National Standards in *What's Your Idea?***

| California State Science Standards (8th Grade): Forces | California State Science Standards: Investigation and Experimentation | National Science Education Standards: Scientific Inquiry (Grades 5-8) |
|---|---|---|
| **8.2. Unbalanced forces cause changes in velocity.**<br><br>b. When an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces.<br><br>c. When the forces on an object are balanced, the motion of the object does not change.<br><br>d. Identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.<br><br>e. When the forces on an object are unbalanced the object will change its motion (speed up, slow down, change direction).<br><br>f. The greater the mass of an object the more force is needed to achieve the same change in motion. | **8.9. Scientific progress is made by asking meaningful questions and conducting careful investigations.**<br><br>Students should develop their own questions and perform investigations.<br><br>a. Plan and conduct a scientific investigation to test a hypothesis.<br><br>b. Evaluate the accuracy and reproducibility of data.<br><br>c. Distinguish between variable and controlled parameters in a test.<br><br>e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables. | **Abilities Necessary to do Scientific Inquiry:**<br><br>• Identify questions that can be answered through scientific investigations.<br><br>• Design and conduct a scientific investigation.<br><br>• Use appropriate tools and techniques to gather, analyze, and interpret data.<br><br>• Develop descriptions, explanations, predictions, and models using evidence.<br><br>• Think critically and logically between evidence and explanations.<br><br>• Recognize and analyze alternative explanation sand predictions.<br><br>• Communicate scientific procedures and explanations. |

In 2009, Surf Street Middle School earned an API (Academic Performance Index) of 935. During that year, 89% of 8th grade students scored proficient or advanced on the California State Test (CST) in science. Of the students who took the 2009 CST science test, 87% of females and 92% of males scored proficient or advanced. All Asian students, 55% of Latino students, and 93% of White students scored proficient or advanced on the 2009 science CST. In 2009, 44% of economically disadvantaged and 92% of non-economically disadvantaged students scored proficient or advanced on the science CST. During the 2008-2009 school year, 38% of English language learner students and 92% of English proficient and English only students scored proficient or advanced on the science CST. Also, in that year, 99% of gifted and talented students and 65% of students diagnosed with a learning disability scored proficient or advanced on the 2009 science CST. While this data shows that certain groups of students at Surf Street Middle School are performing very well on state standardized science tests, it is clear that students who have been diagnosed with a learning disability, students who are English language learners, Latino students, and students who are considered to be socioeconomically disadvantaged perform significantly lower than their peers who do not fall into these categories.

**Table 3: 2009 CST Science Results for Surf Street Middle School**

| **Gender** | **Students Scoring Proficient or Advanced** |
|---|---|
| Male | 92% |
| Female | 87% |
| **Ethnicity** | **Students Scoring Proficient or Advanced** |
| Asian | 100% |
| Latino/a | 55% |
| White | 93% |
| **Economic Background** | **Students Scoring Proficient or Advanced** |
| Disadvantaged | 44% |
| Non-Disadvantaged | 92% |
| **English Language Learners** | **Students Scoring Proficient or Advanced** |
| ELL Students | 38% |
| English Proficient and English Only | 92% |
| **Learning Differences** | **Students Scoring Proficient or Advanced** |
| GATE (Gifted and Talented) | 99% |
| Students with a Learning Disability | 65% |
| **Total Student Population** | **Students Scoring Proficient or Advanced** |
| 302 8$^{th}$ Graders Tested | 89% |

Students at Surf Street Middle School take six yearlong courses including English, math, social studies, physical education, science, and an elective. Students are able to choose their elective from a variety of visual and performing arts classes, Spanish, or math or reading support classes. All eighth grade students are required to take a course in physical science that includes the topics of motion, forces, astronomy, chemical reactions, chemistry of living systems, the periodic table, density, and investigation and experimentation techniques. While funding for science materials from the state is limited, the Parent-Teacher-Student Association (PTSA) is very active in fundraising on campus and parent donations to the science classroom are common and generous.

**Physical Science Classroom**

The *What's Your Idea?* curriculum was implemented in five eighth grade physical science classes. Each class meets for 50 minutes on Mondays and then for 105 minutes two other times that week. With block scheduling, one complication arises when students are absent from school because they miss a high number of curricular minutes and miss out on time with their lab group. Since all eighth grade students at Surf Street Middle School take the same science course, each class includes students from a variety of academic achievement levels. Most students at Surf Street Middle School are at or above grade level in math and English while 21% are performing below grade level in math and 12% are performing below grade level in English Language Arts. During the 2006-2007 school year, when the students participating in this curriculum were in the fifth grade, 23% were performing below grade level in science. This was the last time students were tested in science for the California Standards Tests (CST).

In the classes where I implemented this curriculum, eight students are classified as English language learners and 14 students have Individualized Education Plans (IEPs) due to diagnosed learning disabilities. Because the group of students with whom this curriculum was implemented was heterogeneous in a variety of ways, empathy was problematic because many students had rarely been in social situations with their peers who were of different backgrounds. The classroom environment is set up so that there are eight groups of students each consisting of three to five students. Students sit together at a table and are encouraged to discuss their ideas with their lab group. Before implementing the *What's Your Idea?* curriculum, I was using a curriculum that I developed that included a variety of hands-on activities that give students an opportunity to answer predetermined questions while following predetermined procedures or by making their own procedures. Students have always been encouraged to use the state and district adopted textbook as a reference tool, but I did not use the supplementary materials (i.e. workbooks, lesson plans).

**Implementation**

During the forces and motion unit, I implemented a guided inquiry project where students used ramps and carts and a variety of other materials including items that students were encouraged to bring from outside the classroom. Students worked in groups of three to five to plan an investigation that would answer a question that they generated about forces. Throughout the implementation of this project, students wrote journal entries with their thoughts, ideas, and beliefs about forces as well as how they act in our world along with statements about the perceptions they had about the members of their groups.

Students were given an opportunity to discuss their ideas in small groups and then write about the ideas of their peers. While there are arguments against the capacity of students to benefit from inquiry based learning in a middle school classroom for various reasons as discussed in chapter three, the implementation of this curriculum offered evidence that when inquiry is implemented in a setting where students are able to communicate their ideas to their peers, all students benefit. Table 4 provides a summary overview of the activities of the *What's Your Idea?* curriculum along with the science inquiry skills that students are intended to use and the processes students are intended to follow for each activity.

**Table 4: Overview of the Activities in the *What's Your Idea?* Curriculum**

| Science Lessons | Science Inquiry Skills | Process of Activities |
|---|---|---|
| 1. Activity 1: Eliciting Prior Knowledge<br>2. Activity 2: Finding a Problem<br>3. Activity 3: Developing a Procedure<br>4. Activity 4: Making a Data Table<br>5. Activity 5: Analyzing the Data<br>6. Activity 6: Drawing Conclusions<br>7. Activity 7: Assessing What Was Learned | 1. What do you already know about forces?<br>2. What do you want to know about forces?<br>3. How are you going to answer this problem?<br>4. How are you going to record your data?<br>5. What does your data mean?<br>6. What is the answer to your question?<br>7. What did you learn about forces? | 1. Do the activity on your own.<br>2. Share your ideas with your group.<br>3. Discuss your ideas with your group.<br>4. Decide on the idea your group will use.<br>5. Implement your group's idea.<br>6. Reflect on the process.<br>How have your ideas about your group members changed? |

Table 5 provides an overview of the handouts provided for students in the *What's Your Idea?* curriculum. Some handouts were classified as group collaboration handouts because students were encouraged to share the ideas they wrote on these handouts with other members of their group. Other handouts were classified as confidential handouts because I was the only person who read the information students wrote on these handouts. For every activity, only I used the group checklist handout. Students were expected to reference the group members' responsibilities handouts during each activity.

**Table 5: Overview of the *What's Your Idea?* Curriculum Handouts**

| Activity | Group Collaboration Handouts | Confidential Handouts |
|---|---|---|
| Activity 1: Eliciting Prior Knowledge | | • Pre-Implementation Survey #1<br>• Pre-Implementation Survey #2 |
| Activity 2: Finding a Problem | • Finding a Problem Facilitation Worksheet | • Finding a Problem Group Interactions Reflection |
| Activity 3: Developing a Procedure and Making a Data Table | • Developing a Procedure Facilitation Worksheet<br>• Making a Data Table Facilitation Worksheet | • Developing a Procedure and Making a Data Table Group Interactions Reflection |
| Activity 4: Collecting the Data | • Lab Report Worksheet | |
| Activity 5: Analyzing the Data and Drawing Conclusions | • Analyzing the Data and Drawing Conclusions Worksheet | • Analyzing the Data and Drawing Conclusions Group Interactions Reflection |
| Activity 6: Assessing What Was Learned | | • Post-Implementation Survey |
| Handouts Used for Each Activity | • Group Observation Checklist (teacher use only)<br>• Roles of Group Members (to be shared with students) | |

The remainder of this chapter will provide an in-depth explanation of the activities that I implemented in my classroom. Each section consists of a description of what occurred, rough data that was collected, and modifications I plan to make during future implementations.

**Activity One: Eliciting Prior Knowledge.**

The first activity in the *What's Your Idea?* curriculum took place during a fifty-minute class period. To begin the activity, I told students that we would be starting a unit covering forces and that they would have the opportunity to conduct an investigation of their group's choosing. I informed students that they would be working in groups of three to five students and that the only requirement of the activity was to ask a question that somehow related to the concept of forces and to design and perform an investigation to answer that question.

After explaining the activity to students, I distributed the first pre-implementation survey to students. The survey included the following questions: What do you think of when you hear the word "Force"?

1. Who in this class do you prefer to work with? Why?
2. Who in this class do you prefer not to work with? Why?
3. What do scientists do? Do you think you are a scientist? Why or why not?

Students took about ten minutes to complete the first pre-implementation survey and then returned it to me. I assured students that I would be the only person viewing the answers to any surveys and reflections during this entire project. Students were asked to put their names on the surveys so that I could see if their answers changed throughout the implementation of the activities.

It became clear to me a few minutes after distributing the first pre-implementation survey that students felt comfortable answering the first three questions but had trouble understanding what I expected them to write for the fourth question. Most students were only answering the second part, and many of them were confused by the first part of the question. The following conversation took place between a student who was confused and myself, the interviewer:

> S: I don't get the last question.
> INT: Do you understand any of the questions in the last part?
> S: I don't think I am a scientist.
> INT: Why?
> S: Because I'm not good at science.
> INT: Why do you think you aren't good at science?
> S: Because science is hard for me.
> INT: Do you think science is hard for scientists?
> S: No, it's easy for them.
> INT: Why do you think it is easy for them?
> S: It just is. They just understand it.
> INT: What are they doing that is so easy for them?
> S: Experiments.
> INT: So how could you answer the question, "What do scientists do?"
> S: Scientists do experiments.
> INT: Do you understand the rest of the questions? Do you want to change your answers?
> S: I guess I could say I don't think I am a scientist because experiments are hard for me.

By the end of the conversation it became clear to me that if students put thought into the last part of the question "What do scientists do? Do you think that you are a scientist? Why or why not?" and genuinely answered it based on how they viewed their abilities in the science classroom, then they were also implying an answer to the first question, "What do you think of when you hear the word 'Force?'" For example, the student I interviewed felt that he was not good at science because experiments were "hard" for him, which implied that scientists do experiments easily. To help students with the last question I asked students to answer the first part of number four last. I also asked them to put a lot of thought into their answer and I gave them the example of the student I interviewed above. After this, students had more confidence in answering question number four of the first pre-implementation survey. This instance illustrated to me that the questions I asked students to answer might not have been as clear to them as they were to me. However, after having a discussion with students, it became clear to me why students were confused. This made it easy to adjust the questions so that I could elicit responses that would help me to determine if my goals had been met.

***Groupings***. After students completed the survey, I put each student into one of eight groups. Students were placed into groups completely at random. No criteria was used for putting students in certain groups. Depending on the class size, the groups had between three and five members. I put the names of every student into an online list randomizer so that student names were put in a list over which I had no control. Once this list was made, I informed students about how I made the groups and then split up the groups by putting the first four students on the list in group one and the next four students in group two. I continued putting students into groups using this method until all students were in a group. If there were unassigned students after making eight groups, the remaining students were added to four-person groups until all students were placed into a group. If there were not enough students to make eight groups of four students then I took the last student from groups of four and added them to smaller groups until all groups had at least three students. When students returned to class for the next class period, a 105-minute period, I announced the groupings and had student groups choose a table at which they wanted to work.

Once students sat in their groups, I projected the “Roles of Group Members” handout (Appendix) for all the students to see. I asked students to look at the list and think about people they know in their lives who meet each of the categories listed. I explained to students that there are many other descriptions for the roles of group members and asked students to share some roles that they did not feel were represented on the list. After this discussion I handed out the second pre-implementation survey. I informed students that they were not required to write entire sentences but could write down words that they felt described the role and the strengths of the other students in their groups. To ensure candid responses the students were also assured that no one but myself would see the answers to this survey.

Students took about ten minutes to complete the second pre-implementation survey. While students were completing the second pre-implementation survey, most students seemed to understand what was expected of them but a few students needed to ask clarifying questions. For example, a couple of students asked if it was appropriate to write down that the role of someone in the group would be “slacker” or “the lazy one.” I reminded students that I would be the only one who saw the surveys so they could write down that description if that was how they felt.

***Modifications for Activity One.*** Based on this implementation, I changed the fourth question on the first pre-implementation survey to read, “Do you think that you are a scientist? Why or why not? What do scientists do?” This change was intended to clarify the purpose of the question for students. I also revised the curriculum to give students an opportunity to write down the roles they think their group members will play before projecting the “Roles of Group Members” sheet. Very few students seemed to think critically about the roles their group members would play and just picked a role from the sheet and wrote it down. It would be preferable for students to write down their first impression because the “Roles of Group Members” sheet should be used if only if students cannot think of anything to write.

**Activity Two: Finding a Problem.**

After students completed the second pre-implementation survey, I explained that for the rest of the class period they would begin an investigation that would last over the next few weeks. I informed students that they would have the opportunity to plan a laboratory investigation that their group wants to do and I would not assign them a question. Rather, they would create their own questions within each group. I told students that the only requirement of the investigation was that it needed to focus on answering a question about forces.

I engaged the students in a whole class discussion to think of activities they do in their lives that require the use of forces. I then asked students share these activities with the class. Students answered with responses such as “playing soccer” or participating in other sports, driving (or being in a car), and walking around school. I asked students to silently think about an investigation they could complete that would test the way forces act on an object. I told students that they would be allowed to use any materials appropriate to bring to school and showed students the materials listed on the “Finding a Problem” worksheet included in the Appendix. I then explained that I would distribute the “Finding a Problem” worksheet and reminded students that they were not limited to using the materials on the worksheet and that they could write down more than one question.

I gave students about five minutes to write down any questions they had about forces. I informed students that they did not necessarily need to know how they would perform the investigation. Students were then given the example of a large truck hitting another object. I told students that they would not be able to use a large truck in their investigation, but that they could come up with other techniques in the investigation that would answer their question. Students were encouraged to ask any question that they wanted to answer. If the list of materials helped them ask a question, then they could use it, but I encouraged students to come up with a question without looking at the list.

After students had an opportunity to write a question, I explained, in detail, the protocol for discussing ideas with group members that would last for the entire investigation. I explained to students that each group member would have the opportunity to share the ideas they wrote down and that when a group member was sharing, every other group member needed to be respectful of the person who was speaking. I asked students how they could be respectful of the person sharing. Students responded with ideas including, "don't talk," "don't put them down," and "think about the ideas." I asked students to give each member an opportunity to share all of their ideas without interruption. I explained to students that it would be appropriate for them to ask questions about the ideas of their group members if they didn't understand, but that these questions should be asked after the person had finished explaining their ideas.

Before students contributed their ideas, I reminded them to write down any of their group members' ideas that they thought were interesting to answer the second question on their worksheet. I explained that if students found no other ideas interesting that they should write if their ideas had changed at all since they came up with questions on their own.

After students finished sharing their ideas, I informed groups that they needed to decide on one question that they would like to investigate. Their questions could combine two or more different questions that they felt were interesting. Students took about ten minutes to decide on a question that they wanted to answer as a group. After all groups had finished recording the question they chose to investigate I distributed the "Finding a Problem Group Reflection Sheet." I again reminded students that I would be the only person who would see their answers. I projected the "Roles of Group Members" handout to help students in case they were having trouble thinking of words to describe the roles of their group members. Students took about ten minutes to finish the reflection.

***Modifications for Activity 2.*** It became clear to me that students were drawn to the list of materials on the "Finding a Problem" worksheet and that this list influenced the question they asked more than I had intended. The goal of this curriculum was for students to ask questions that had a real-world application that was important to them and then find and use materials to answer this question. By providing the materials list before students had the opportunity to write down a question, students seemed to have more trouble writing a question that they did not think they could answer with the items listed on the worksheet. For instance, all of the sample questions used only objects from the supplied list except for the question that asked, "How big of a splat will a water balloon make when dropped from different heights?" I hoped that students would inquire into questions that they already had about forces and would not come up with questions after seeing the materials they were allowed to use. In order to avoid this tendency, I revised the curriculum by eliminating the list of materials on the worksheet. Students will now have an opportunity to write down a question and after students are done writing the question, the list will be projected to help those students who had trouble thinking of a question. Prior to projecting the list, students who have already written a question will be asked to not change the question after seeing the materials list.

**Table 6: Examples of Types of Questions asked by Students in Activity Two**

| Topic | Sample Student Generated Question |
|---|---|
| Center of Mass | • What are safer, cars with a low central mass or cars with a high central mass? |
| Speed and Force | • How big of a splat will a water balloon make when dropped from different heights? |
| Tension Force | • How much does a cart get pulled back when it rolls down a hill and is attached to the top of the ramp by a rubber band? |
| Friction Force | • Will the cart go farther on the rough track or normal track? |
| Air Resistance | • How does the size or hole in the bottom of the airplane affect the flight? |
| Inertia | • If there is an object on a block and a car hits the block, what happens to the object? |
| Mass and Force | • If two cars, with different weights, crash into each other, which will have more damage? |
| Speed and Mass | • Do heavier objects go faster than lighter objects? |
| Angles and Force | • How does the way you crash affect the impact? |

**Activity Three: Developing a Procedure and Making a Data Table.**

At the beginning of the next class period, which lasted for a longer amount of time, I reminded students that they would be investigating the question that their group decided to ask. Since some groups asked questions about items to which we did not have access (large trucks, cannonballs), I reminded students that they could set up an investigation for the question using different materials. I reminded them of an episode of the television show *Mythbusters* that we watched as a class in which the scientists tested out different theories that were used to explain why the LZ 129 Hindenburg Zeppelin caught on fire in 1937. In the episode, the scientists did not recreate the Zeppelin because it was much too big, but they recreated a smaller model so that they could test their ideas. I also reminded students that their procedures should be clear enough that anyone who could read can understand how to complete the investigation.

I distributed the "Developing a Procedure" worksheet and gave students about ten minutes to write a procedure to test their question. By allowing students time to write a procedure individually, each student had time to recorder her or his ideas without being influenced by their group members. After students finished writing their individual procedures I instructed them to share their procedures with the group using the same protocol for group discussions that students used in the second activity, "Finding a Problem." After all students had the opportunity to share their ideas, I asked groups to write a procedure that either used the best idea presented in the group or to combine any ideas that they thought could make a good procedure. This step proved to be extremely surprising because students included ideas from other members of the group, which was an indication that some of my research goals were already being met.

For example, one group set out to answer the question, "How does the mass of an object change how much force it hits another object with?"  This group used one member's ideas to use the plastic carts and fill them with different amounts of mass to see how far they pushed two wooden blocks. The group used another member's idea of performing more than one trial. While writing the procedure, a third group member contributed an idea of how to ensure that only one variable was being tested. Finally, the last member later contributed the idea of putting a textbook at the end of the track so that the cart did not fly off the table at the end of the trial.

After students had about thirty minutes to develop their procedures, I distributed the "Making a Data Table" worksheet and instructed students to make a data table that they could use to record their data. I reminded students that they should be able to record all of the data they collected during their investigation in their data table. I also reminded students that the data table should be easy to read so that someone could determine the main points of their procedure by looking at their data table. After students worked on their data table for about ten minutes, I instructed them to discuss their ideas as a group using the protocols for group discussions used earlier and then to decide on a data table as a group.

After all groups had finished writing down the procedure and data table I distributed the "Developing a Procedure and Making a Data Table Group Reflection Sheet."  I again reminded students that I would be the only person who would see their answers. I projected the "Roles of Group Members" handout to help students in case they were having trouble thinking of words to describe the roles of their group members. Students took about ten minutes to finish the reflection. At the end of the class period, I reminded students to bring in any supplies they would need to complete their procedure to the next class period. Table 7 exemplifies my expectations that student groups would discuss and integrate the ideas of each member to create one group procedure. By looking at the final procedure, it is clear that the entire group used ideas from each of its members. Although all students had similar procedures, Student One was the only student who used the phrase, "Repeat steps…with the…" The student's wording emulates the wording used in textbook procedures, and in the writing of professional scientists. Student Two had the idea to give each group member a job; the group then further specified how to do this distribute responsibilities in the final procedure. Student Three had the original idea for a data collection procedure (for students to position their eyes level with where the marble would bounce) that the group implemented in their procedure. Finally, Student Four had the idea to complete more than one trial. Although the group did not implement Student Four's idea completely, they did not take the first results and Student Four was the only student who had the idea to rely on more than one trial. The final procedure utilized ideas from all four group members.

**Table 7: Example of One Group Process of Developing a Data Table**

| | |
|---|---|
| Group Question | Does a metal or a glass marble bounce higher on a wood/concrete/carpet surface from 1 meter? |
| Student 1's Procedure | 1. Drop the metal marble from three feet in the air.<br>2. Record how high it bounces.<br>3. Repeat steps 1-2 with the glass marble.<br>4. Repeat steps 1-3 on carpet and then concrete. |
| Student 2's Procedure | 1. Give each person in the group a job to do.<br>2. Drop the glass marble and record how high it bounces on the concrete.<br>3. Drop the metal marble and record how high it bounces on the concrete.<br>4. Drop the glass marble and record how high it bounces on the table.<br>5. Drop the metal marble and record how high it bounces on the table.<br>6. Drop the glass marble and record how high it bounces on the carpet.<br>7. Drop the metal marble and record how high it bounces on the carpet. |
| Student 3's Procedure | 1. Drop the metal marble on the table and get on eye level with it to see how high it bounces.<br>2. Do that again with the glass marble.<br>3. Then do it on the concrete and then the carpet. |
| Student 4's Procedure | 1. Drop the glass marble from the top of a meter stick three times.<br>2. Find the average distance it bounced on the table.<br>3. Drip the metal marble from the top of a meter stick three times.<br>4. Repeat for the carpet and then for the concrete. |
| Group's Final Procedure | 1. Pick one person to drop the marble and hold the meterstick, one person to record the data, and two people to determine how high the marble bounced.<br>2. These people should be the same for the whole experiment so that the way individual people do the jobs does not change the results.<br>3. Drop the glass marble from the top of a meterstick onto the table.<br>4. Measure how high it bounces by having two group members get their eyes level with where they think the marble will bounce to.<br>5. Continue dropping it until the two group members agree on the how high the marble bounces.<br>6. Repeat steps 1-3 with the metal marble.<br>7. Repeat steps 1-4 on the carpet and then on the grass. |

When students turned in their daily reflections it became clear that they all used each other's ideas in developing their final procedure. When asked, "Who had the best idea of the day? What was the idea?" they all listed different students.

> Student 1: Student 4. She told us to do it more than once.
> Student 2: Everyone. We used everyones idea.
> Student 3: Me. I knew that we had to get down to really see where the marble ended up.
> Student 4: Student 2. He had the idea of what everyone should do.

The curriculum goal of this activity was for students to use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces. This group met the goal of this curriculum, as a large majority of the groups did, by using the ideas of each individual student to plan the overall procedure. The success of this group showed me that major curricular revisions for this activity were not needed.

***Modifications for Activity Three.*** Although students had been following procedures for scientific investigations for most of the school year and had followed procedures in previous science classes they had taken, most students had not had much experience in writing procedures. In future implementations of this curriculum, students will be shown samples of procedures that are unrelated to investigations on forces. This way, students will not be influenced by the procedures themselves but will understand how procedures should be written. Only about half of the groups decided to do more than one trial during an investigation until the class had a discussion about the reason for completing more than one trial. If students had seen procedures for scientific investigations, then they may have been more likely to come up with the idea to complete more than one trial before being prompted by other members of the class.

**Activity Four: Collecting the Data.**

The fourth activity in this curriculum was implemented during a 105-minute class period. I told students that they could use all of the class period if they needed that amount of time to collect data. I also informed students that they could use extra time during the next class period or at lunch to collect more data if the class period was not enough time. All groups completed their data collection within the allocated class period. Before allowing students to begin implementing their procedure, I told them that they might need to change their procedure and data table during their investigation when they realized that steps were not as clear as they needed to be or that the data table did not fit all of the data they needed to record. I encouraged them to make changes that would help their investigation better test their question, but that they must discuss any changes with every member of the group. I told students that if group members disagreed about a change, they could complete the procedure two different ways and record the data in two separate data tables. They could then decide which data to use when analyzing their data.

Before students started following their procedure, I distributed the lab write-up worksheet. I instructed students to agree on a title for their experiment and to write that title at the top of the write-up. I also instructed students to write the question they intended to answer and to think about their prediction for what they thought would occur during the investigation. This prediction needed to be written in the “if-then” format. In this format, students write about what they think will happen if they set up their investigation in a certain way. For example, one student wrote, “If toy cars of different masses hit a toy bus, then the heaviest car will hit the toy bus the hardest and make it move the most." I asked students to refrain from writing the procedure and data table on their lab-write up until after they had finished the procedure. I reminded them that they could make changes to their procedure and data table during the activity and the purpose of the lab write-up was to report what they actually did. For this reason, it was important for students to refrain from writing their procedure until they had ensured that the procedure they wrote was what they had actually done.

During the activity, I gave students freedom to change their procedures and record their data. Many groups finished collecting data quickly but then came up with other variables to test, which often occurred when I have implemented inquiry-based activities in the past. For example, one group tested the distance that different sized toy cars pushed a toy bus after traveling down the ramp. After they were finished collecting that data, they decided to measure how far each of the vehicles flew off the table after they went down the ramp. The group quickly made a second data table for this second investigation.

After students had finished implementing their procedures, I asked them to complete the materials, procedure, and results sections of their lab write-ups. I reminded students to record exactly what they used for the materials section, the exact steps they followed for the procedure section, and all of the important data they recorded in the results section.

***Modifications for Activity Four.*** I was not prepared for the number of groups who chose to complete more than one investigation during the time allotted for this activity. Some students asked if they were allowed to change their question and procedure during the activity and I encouraged them to keep their original questions and procedures because they had already written their hypotheses for these questions. However, I announced to the class that they would be able to discuss their other findings when they reported their findings to the class. I also asked that they keep in mind the people in their group who came up with good ideas even after they had finished implementing their procedures. I revised the curriculum to include a space for new ideas in the lab write-up so that students are encouraged to ask more questions that they can answer either on their own or during future class meetings.

**Activity Five: Analyzing the Data and Drawing Conclusions.**

The fifth activity in the *What's Your Idea?* curriculum took place during the day following the fourth activity. By implementing the fifth activity a day after students performed their procedure, I hoped that students would have had an opportunity to think about their results and reflect on them before being asked to write an analysis and a conclusion. When the class period started, students were asked to take out the lab write-up that they had begun to complete during the previous day's activity. I gave students a few minutes to read over their procedures and look at the results before handing out the "Analyzing the Data and Drawing Conclusions" worksheet. I asked students what the difference was between an analysis and conclusion. Students discussed the differences and each class came to the conclusion that the analysis describes the data while the conclusion describes what this data means.

Students took about ten minutes to complete their answers on their own. It was important for students to complete their analysis of the data as individuals before discussing their ideas as a group because each student may have had a different understanding of what the data means. Students then discussed their answers as a group using the protocols for group discussions used earlier. I encouraged students not to copy the answers of their group members. Instead, I asked students to write their analysis and conclusion in their own words. However, I encouraged them to use the ideas they liked from their peers and to combine these ideas with the ones they already had. This aspect of the activity was probably the most difficult because students had become accustomed to having the same information as their group members on their lab write-up so it seemed to be natural to them to all write the same thing. It seemed as though students were so used to collaborating and using the ideas of their peers to enhance their own, that they were hesitant to use only their own ideas in the analysis. While most students ended up having similar analyses and conclusions as their group members, nine groups had members who analyzed the data differently and drew different conclusions, as shown in Table 8.

The example in Table 8 shows that, although all students followed the same procedure and discussed the same results, some of them still analyzed the data differently from each other and reached different conclusions. It was helpful for me as the teacher to see which students were able to reach higher-level conclusions after discussing the results with their group members, and which students only made surface level conclusions. I was also surprised that no students reached erroneous conclusions based on the data they collected. This can be attributed to the fact that all students shared their ideas and that the planning of the investigation was structured so students were able to complete it in an organized way.

**Table 8: Example of One Group Analysis and Conclusion of the Data**

| Group Question | How does weight affect force in a car crash? |
|---|---|
| Student 1 | Analysis: The results told me that the one that had the most mass had the most force.<br><br>Conclusion: The more mass an object has the more force it had. |
| Student 2 | Analysis: The higher mass moves less in a car crash and the lighter mass moves farther back.<br><br>Conclusion: That in a car crash it is better to have a heavier car. |
| Student 3 | Analysis: The cars with greater mass had more force and pushed the lighter cars farther back. The cars with more mass went the fastest and furthest but was pushed back the least.<br><br>Conclusion: In a car crash, with more mass, there will be greater force. |
| Student 4 | Analysis: The car with the most mass transferred the most force.<br><br>Conclusion: The more mass an object has the more force it transfers. |
| Student 5 | Analysis: The greatest weight had the most force.<br><br>Conclusion: The greater weight/mass makes greater force. |

After all students had finished writing their analyses and conclusions on their lab write-up, I distributed the “Analyzing the Data and Drawing Conclusions Group Reflection Sheet.” I again reminded students that I would be the only person who would see their answers. I projected the “Roles of Group Members” handout to help students in case they were having trouble thinking of words to describe the roles of their group members. Students took about ten minutes to finish the reflection.

***Modifications for Activity Five.*** I revised the curriculum to clarify that each student in the group should have a conclusion written in their own words. This is now the only section of the lab-write up that is not an exact replica for every group member. After performing the experiment, students may not come to the same conclusion as their peers, so by asking them to write a unique conclusion after discussing it with their peers, they are given an opportunity to decide on their own what conclusion they have reached. The revised curriculum encourages students to give an example of something from outside the classroom that they understand better because of the investigation they completed. This helps students tie their conclusion to the original idea that generated the investigation question. If students are required to use a real-world example then they will be more likely to have different questions than their group members. When conclusions are written about how experimental results an individual found relates to his or her own life, each conclusion will be unique because each student has had different experiences.

**Activity Six: Assessing What Was Learned**

The final activity in the *What's Your Idea?* curriculum took place during a fifty minute class period. To begin the activity, I told students that they would be reflecting on the past few weeks. I continued to explain that students would think about how the planning of their investigation had changed the way they see themselves and their group members as scientists. I informed students that they would think about how each member of their group contributed to the ideas that the group implemented for the investigation. The post-implementation survey that can be found in the Appendix asked students a variety of questions in regards to how the question they asked relates to their own lives, how their group went about creating a procedure that would help them answer their question, and how their views of their group members have changed.

After explaining the activity to students, I distributed the post-implementation survey for students to complete. Students took about ten minutes to compete the post-implementation survey and then returned it to me. I reminded students that I would be the only person viewing their answers to the survey.

***Modifications for Activity Six.*** One issue that became clear was that a few students answered the first and second questions of the post-implementation survey with either "yes" or "no" responses. The first question asked, "Before this activity, whom in your group would you have picked to be in your group?" and the second question asked, "After this activity is there anyone in your group who you would choose to work with again?" As soon as I saw that students did not write any names, I handed them back to those students and asked them to add the names of the students with whom they would choose to work. I revised the survey to include, "Please provide names" after both of the questions.

# CHAPTER VII. EVALUATION OF THE *WHAT'S YOUR IDEA?* CURRICULUM

The overall goal of the *What's Your Idea?* curriculum was to support students in valuing the ideas of their peers given the usefulness of social interaction to the development of understanding. The specific activities of the curriculum I implemented were for students to ask a question about force and then, after using the ideas of their peers, to design an investigation, and connect the answer they found to something relevant to their own lives outside the classroom. Through this process, students increased the empathy they had for their peers by partaking in scaffolded reflections about peer interactions. To use empathy as a tool in a group learning activity, students must be able to grasp the responses and reactions of others and must try to understand another person, people, or culture (Wiggins and McTighe, 2006). Having empathy leads to students having an overall understanding of the world in which they live. To evaluate the effectiveness and success of the *What's Your Idea?* curriculum, I used four principle sources of data: pre- and post-implementation surveys, daily written reflections, teacher observations, and student interviews. The pre- and post-implementation surveys and daily reflections were individual assignments that students completed in class, while the observations and student interviews were recorded through written notes. This combination of student-produced writing, teacher observation, and interviews provided the necessary information, and perspectives, to evaluate the effectiveness of the curriculum.

## Data Collection Strategies

I used the data from the pre-implementation survey to make a sociogram that showed how students interacted with each other in the classroom. Once students were placed into groups, I asked them to predict the roles their group members would play in the group investigation and to list the strengths they thought each member of the group brought to the task. This prediction served as a way for me to understand students' reasoning for their choices and to help students see how their own reasoning was challenged or confirmed by their experience. The pre-implementation surveys served as an essential foundational component in determining if the curriculum goals were met because they helped me to determine if the empathy students had for each other changed over the course of the implementation of the curriculum.

### Pre- and Post-Implementation Surveys

The pre-implementation survey asks students the following questions:

1. What do you think of when you hear the word "Force"?
2. Who in this class do you prefer to work with? Why?
3. Who in this class do you prefer to not work with? Why?
4. What do scientists do?  Do you think that you are a scientist? Why or why not?

After completing the activities, I asked students to complete a post-implementation survey that asked them to reflect on the outcomes of their activities. I asked them if they would have chosen any of their group members to be in their group before the activities and if, after the activities, they would choose to work with members of their group again. In the post-implementation survey, I also asked students how their perceptions of their group members changed over the course of the activities and how the group came up with the ideas they chose to implement. Finally, the post-implementation survey asked students what they learned about science during the activities, if what they learned related to their own lives, and if they saw themselves as scientists.

**Daily Student Reflections**

In the daily student written reflections, I asked students to reevaluate the roles and strengths of each of their group members so that I could determine if one or more students tended to be the main contributor during that activity. I could determine if one student seemed to have the most used ideas throughout the entire implementation of the curriculum, if students equally contributed on each activity, or if different students contributed ideas during different activities. I also asked students to write down which peer had the best idea of the day which helped me to see if different student ideas were used on different days. This way, I was able to determine if one student was dominating the group decisions or if many students were making substantial contributions through collaboration and negotiation. I was also able to see if the second research goal, that students use the ideas of their peers to develop an investigation, had been met.

In addition, students were asked about the roles they felt their group members played and the strengths they thought each member brought to the activity in a format where they were able to give an open-ended answer. If students changed their perceptions of their peers in a positive way, it was clear that they were increasing their positive feelings of these peers. This increase could lead to a greater understanding of how a student's peers could contribute to everyone's learning in an academic setting. However, I also looked for indications in the reflections that students valued the ideas of their peers while they did not necessarily have a positive view of that peer. Another purpose of the daily reflections is that they supported students in thinking about their own beliefs and how they changed over the course of the activities.

### Student Interviews and Group Observations

Student interviews and group observations were a third evaluation strategy used to determine the effectiveness of the *What's Your Idea?* curriculum. Throughout the process, I selected four groups out of the 40 groups total that had students who demonstrated negative views of some peers. By interviewing students and observing groups throughout the process, I recorded student statements that indicated if views of students were changing. In order to observe groups more efficiently, I used a group work assessment checklist that can be found in the Appendix. This checklist provides space to record observations of specific behaviors that occurred during group work and to write down students' statements.

## Examining the Data

To begin analyzing the data, I created group packets that combined the student evidence for an entire group into one data set. Individual student packets consisted of student's pre-implementation survey, daily reflections, and the student's post-implementation survey. I then put each individual packet into the group packets with other members of this student's group. Each group packet consisted of an individual student packet for each student in the group, the group observation checklist, and student interview notes. For each class, there were eight group packets, so there were 40 group packets total from my five classes to analyze to see if the curricular goals had been met.

Throughout the implementation of the *What's Your Idea?* curriculum, I noticed five behaviors of students who were engaged in the curriculum that will have an effect on my future teaching of science. The first four things that I noticed were used to determine if the goals set forth in this curriculum were met. These things that I noticed were that through using the *What's Your Idea?* curriculum, students increased their understanding of forces, used the ideas of their peers in planning an investigation, increased the number of students in their group with whom they would work, and gained more positive views of their peers. The fifth and final thing that I noticed was a trend that, although not directly related to my goals, helped me to determine if the overall goal, for students to value the ideas of their peers more than they previously did, had been met. The final thing I noticed was that students became more empathetic towards the students in their group.

**Goal 1: Students Incorporate Science into Everyday Lives**

To determine if this goal had been met, I analyzed the first pre-implementation survey question that asked, "What do you think of when you hear the word "Force"? I determined whether student answers contained correct scientific information. I then looked at the fifth post-implementation survey question that asked, "What did you learn about science in this activity?" and the sixth post-implementation survey question that asked, "How did the activity relate to your own life or something outside of the classroom?" I determined if students were able to answer the prompt by relating the information they found to something outside of the classroom. This analysis led to the first finding.

**Finding 1: For the study group in this curriculum, there was an increase in the number of students who showed an understanding of forces after the implementation of the activity compared to before the implementation of the activity. 67% of students (*n* = 155) related the information they found in their investigation to something in their own lives or something outside of the classroom.**

Before the implementation of this activity, students were asked to answer the question, “What do you think of when you hear the word ‘Force’?” on Pre-Implementation Survey #1. Many student answers consisted of one word responses and did not show a scientific understanding of the concept related to forces. Some students, however, did have a correct, although usually not well developed, understanding of a concept related to forces. Table 9 illustrates answers that were determined to be scientifically correct compared to those that were not considered to be scientifically correct.

**Table 9: Pre-Activity Understandings of Forces**

| Phrases Showing an Understanding | Phrases Not Showing an Understanding |
|---|---|
| • The power necessary to make objects move.<br>• The amount of weight against an object.<br>• Someone or something pushing something.<br>• How heavily something is disturbed.<br>• Two objects being pushed together.<br>• An object crashing into something.<br>• The amounts of push or pull on an object.<br>• Something pushing down or up, like gravity. | • To push someone into doing something.<br>• Star Wars<br>• Superheroes<br>• Not choosing to do what you want to do.<br>• Something really strong.<br>• Single word answers including:<br>  o Power<br>  o Speed<br>  o Energy<br>  o Moving<br>  o Science |

After the implementation of this activity, students answered a question on their post-implementation survey that asked, "What did you learn about science during this activity?" The answers that students gave for this question, after they had implemented the procedure for their scientific investigation, showed, for 67% of the students, a more scientifically correct understanding of concepts related to forces. Table 10 distinguishes between answers that showed a scientifically correct understanding of a concept related to forces compared to those that did not. This finding suggests that a majority of students developed a deeper and more sophisticated understanding of a concept related to forces during the implemented activities. A majority of students referenced the Star Wars movie in the pre-implementation survey. However, most of these students described a correct scientific phenomena in the post-implementation survey.

**Table 10: Post-Activity Understandings of Forces**

| Phrases Showing an Understanding | Phrases Not Showing an Understanding |
|---|---|
| • The mass of an object affects how much force it exerts.<br>• The speed of an object affects how much force it exerts.<br>• The higher something is dropped from, the more force it exerts on what it hits.<br>• The amount of force needed to drag an item depends on the surface it is on.<br>• F = ma | • Undeveloped answers including:<br>o How motion works<br>o Motion and Force<br>o Speed and Force<br>o About car crashes.<br>• Nothing<br>• That force has to be released from things and that it can be released in different forms. |

Overall, as shown in Figure 1, the number of students who showed an understanding of forces before the implementation of the activity increased after the implementation of the activity. An increase in conceptual understandings would be expected from most students after taking part in a curriculum, but this result shows that focusing on the social interactions between students did not take away from their conceptual understandings. There were no students who changed from a scientifically correct understanding to an understanding that was not scientifically correct. Thus, 37 students changed from having an incorrect or no scientific understanding of forces to having a scientifically correct understanding of forces. At the end of the activity, 58 students still did not have a scientifically correct understanding of forces showing that some students would still need additional support in developing a conceptual understanding regarding forces.

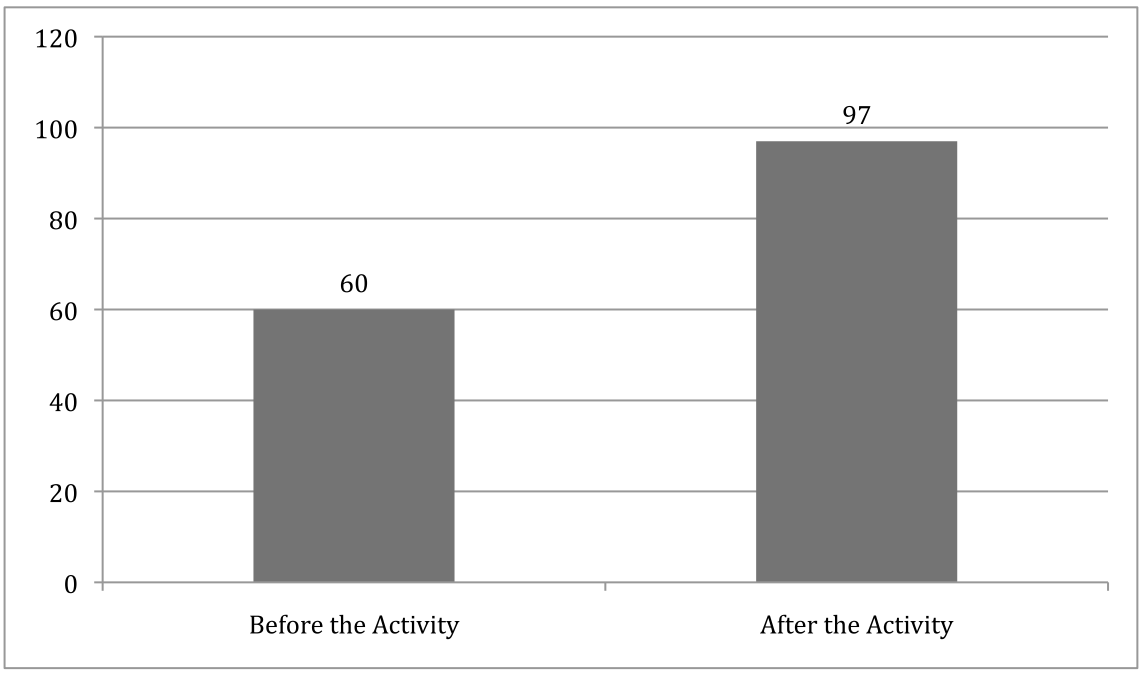


**Figure 1: Students Showing a Scientifically Correct Understanding of Forces**

In the post-implementation survey, students were also asked to answer the question, “How did the activity relate to your own life or something outside the classroom?” This question was the main determinate in whether or not the first goal of the curriculum, for students to relate the investigation they completed to their own lives, was met. Table 11 gives examples of phrases students used that helped determine if they related the activity they completed to their own lives. If students did not explain how a topic related to their own lives then I could not determine if they had a scientifically correct understanding of forces, so I coded these responses as "underdeveloped."

**Table 11: Phrases Relating the Activity to Students' Lives**

| Topics Relating Science to Life | Topics Not Relating Science to Life |
|---|---|
| • Discussion of the force involved in:<br>  o Car Crashes/Car Safety<br>  o Video Games<br>  o Skateboarding<br>• Discussion of how the height of a drop causes damage to an object.<br>• Discussion of how surfaces affect the force needed to slide objects. | • Stating that the experiment did not relate to anything outside of the classroom.<br>• Writing a phrase but not elaborating on it including:<br>  o Car Crashes/Car Safety<br>  o Video Games<br>  o Skateboarding |

The number of students (n = 155) who related the activity to their own lives or something outside of the classroom is shown in Figure 2.

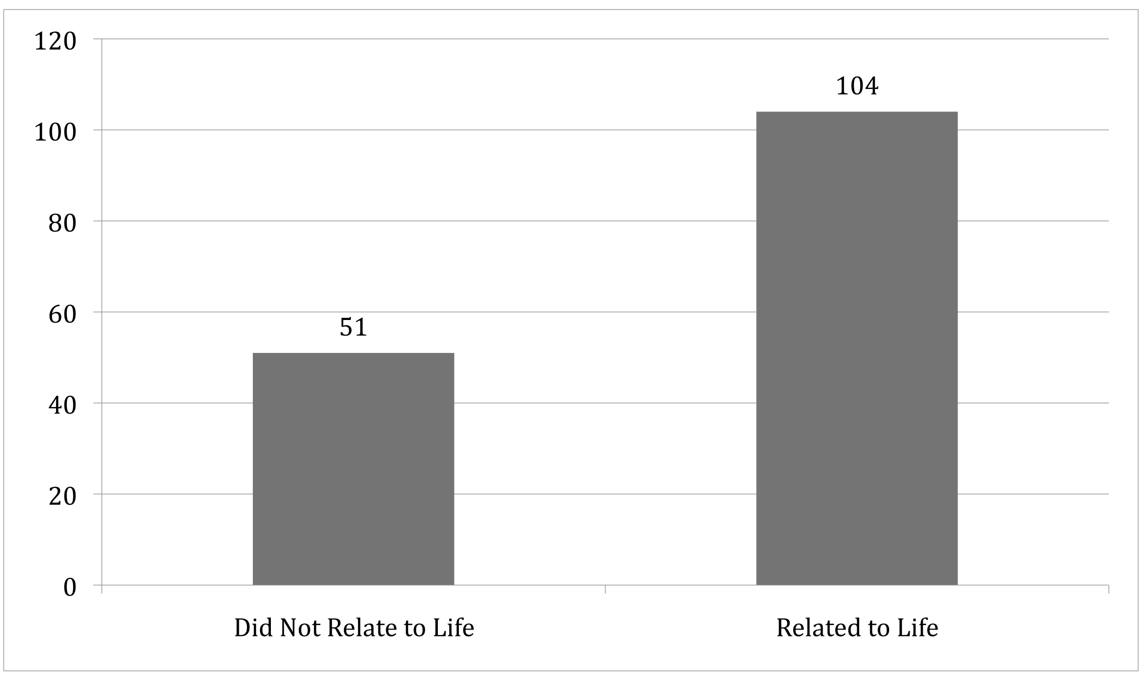


**Figure 2: Number of Students Who Related the Activity to Their Own Lives**

The number of students who had a scientifically correct understanding of forces increased throughout the implementation of this activity. Also, a majority of students related the concepts they learned in their investigations to their own lives. One issue that may have effected the number of students who were able to relate the concepts related to forces to their own lives was the fact that when I asked the question I expected students to focus on how the science of the activity related to their own lives and this expectation was not explicit to students. However, twelve students answered the question by writing about what they learned about group work or about science experimentation. These students may have either misinterpreted the question, or perhaps the reflections they made on the process of working as a group had more of an impact on them as learners than the scientific concepts. These students wrote things such as, "I learned that sometimes I like working with people who I would not have chosen to work with" or "I learned how to make sure that labs test what they are supposed to test." Also, a few students said that they did not learn anything that they did not already know. If the question had asked, "What did the investigation you planned show you about science?" then I would have had a better idea as to if the first goal of the curriculum had been met. Overall, 67% of students related the science aspect of their activity to their own lives even though the question did not explicitly ask them to do so. When I counted the number of students who related the activity to either academic or social aspects of their own life, I found that 81% of students related the activity to their own lives. This finding shows that most students had an increased conceptual understanding of a concept related to forces after the implementation of the *What's Your Idea?* curriculum, which led to the first finding.

**Goal 2: Students Use Their Peers' Ideas to Plan a Scientific Investigation**

To determine if the second goal had been met, I looked at the group reflection sheets to see if different students were determined by their group to have the "best ideas of the day" and if all students in the group agreed that was the best idea of the day. This analysis helped me to determine how many students' ideas were used throughout the implementation of the investigation and also how many students' ideas were valued by at least one other group member throughout the process.

**Finding 2: Throughout the implementation 97% of students (*n* = 155) had their ideas used by their group during the activity.**

After each activity in the *What's Your Idea?* curriculum, students answered the question, "Who had the best idea of the day?" In order to prepare for this question, students wrote about the roles and strengths of their group members so that they could remember how each person contributed to the group during the day. Students also answered the questions: who had the best idea of the day, what was the idea, and why did you think the idea was the best idea of the day? After collecting these reflections for each activity from each group member, I tallied the number of students who were nominated by their group to have had the best idea of the day by at least one group member for at least one activity. At times, all of the students in the group wrote down the same person as having the best idea of the day, but usually group members nominated ideas from different peers as being the best of the day. By reading the explanations of why students chose different people it became clear that, in most cases, this was merely a difference of opinion. In almost every case, if a student's idea was written down as the best idea of the day, that idea was very evident in the final lab write-ups of the group. The ideas that were listed as the best ideas of the day were always scientifically accurate showing that students were probably critical of the inaccurate ideas of their peers. For data collection purposes, I assumed that if another student wrote down any student's idea as being the best idea of the day, then that student had contributed to the ideas of the group. I felt that this was a reasonable assumption because in a large majority of cases the idea was explicitly shown in the lab write-up. For the two instances where this was not the case, the groups had changed their investigation midway through the implementation of the curriculum because they could not find the materials they needed. While these groups did not necessarily use the ideas that they thought were best, these ideas had, at some point, contributed to the overall group investigation. A student could have contributed an idea during any of the activities in order to be considered a contributing member of the group. The goal of this curriculum was that all students would contribute ideas to the group. Figure 3 shows the number of students who contributed ideas that were used by the group and those who did not contribute.

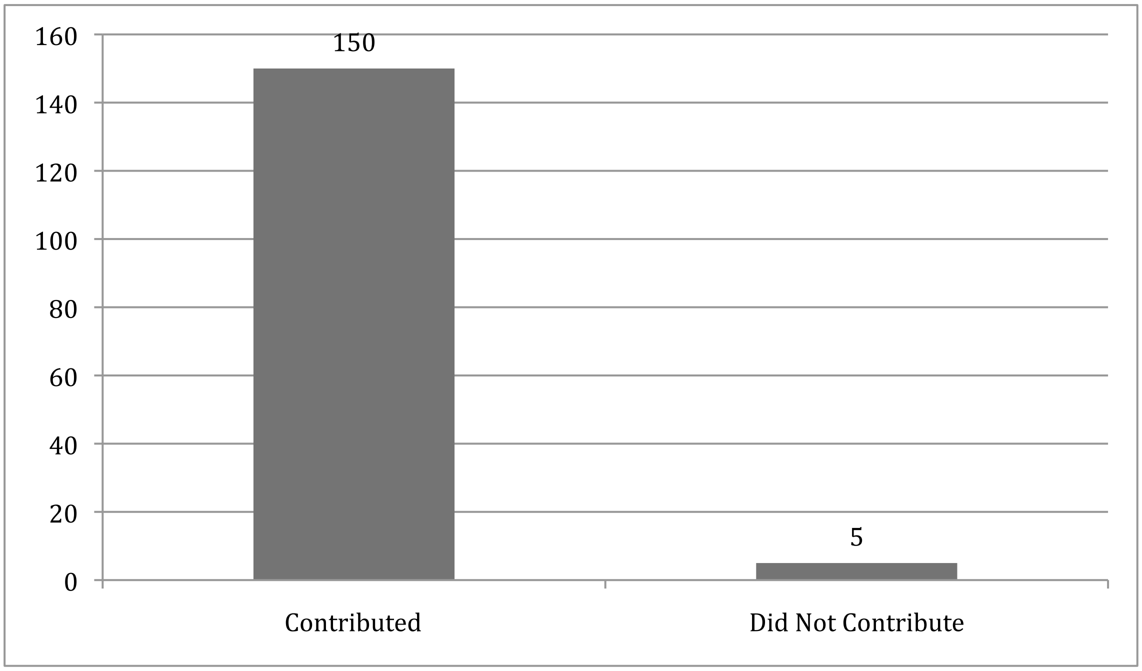


**Figure 3: Number of students who contributed to the ideas of their group.**

Almost all (97%) of the students were credited by one of their group members as having the best idea of the day during activities two through five showing that almost every student contributed to their group's investigation. Before the start of this investigation, I regularly noticed certain students dominating conversations in lab groups. After the implementation, however, almost all students had contributed to their group's investigation.

**Goal 3: Students Increase Empathy for Their Peers**

I determined if this goal was met by looking at students' first and second answers on the post-implementation survey to see if each student increased or decreased the number of people with whom they chose to work to see if students were more empathetic toward other group members. I used these to first see if students changed from their initial feelings of positive, indifferent, or negative feelings toward group members to positive, indifferent, or negative feelings toward group members after the completion of the project. I then looked at the statements students wrote to determine if students had become more empathetic towards their peers. While students may not have increased their views of their peers in a positive direction, they may have first-hand evidence of the strengths and weaknesses their peers brought to the academic work rather than basing their judgment on pre-conceived notions. This analysis led me to the third and fourth findings.

**Finding 3: 48% of students (*n* = 155) increased the number of individuals in their group with whom they would choose to work and 70% of students (*n* = 155) would work with at least one member of their group again.**

During the post-implementation survey, students answered the question, “Before this project was there anyone in your group who you would have chosen as your group member?” Students then answered the question, “After this project is there anyone in your group who you would choose to work with again?” Using this data, I determined if the number of people each student would work with had increased, decreased, or stayed the same. I coded the surveys and grouped them based on if the number of increased, stayed the same, or decreased responses.

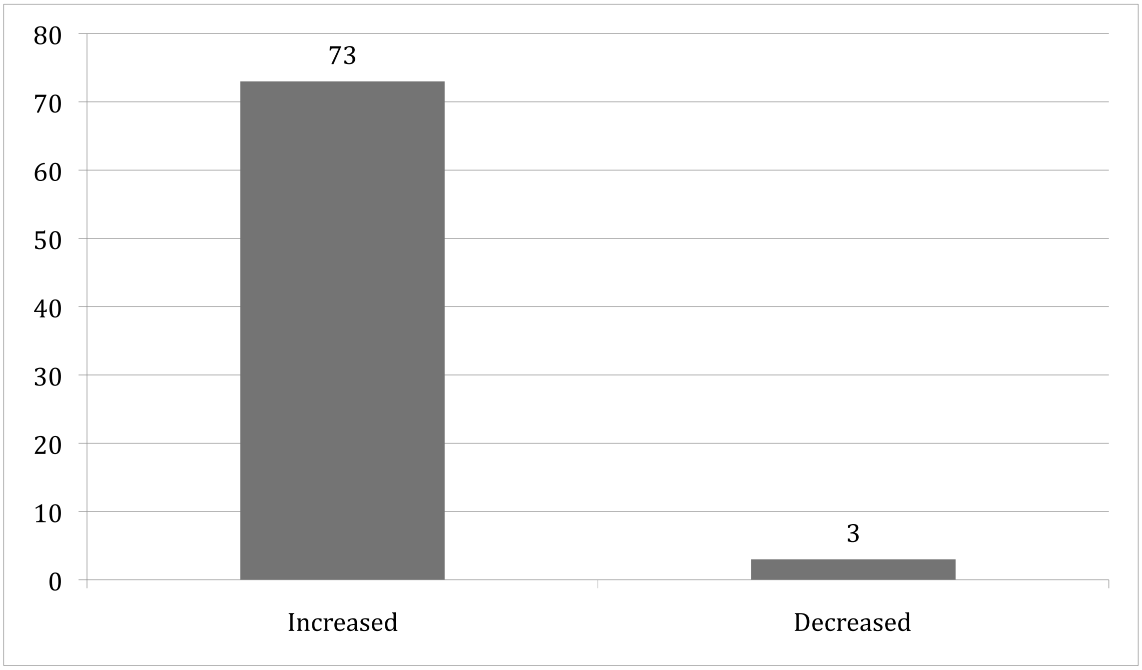


**Figure 4: Number of Students Who Increased or Decreased the Number of Classmates with whom an Individual Student Would Choose to Work**

Figure 4 illustrates that most students increased the number of students with whom they would choose to work in future activities. While the data shows that students were much more likely to increase the number of group members with whom they would choose to work, 77 students did not change the number of students with whom they would choose to work. If a student would, after a given activity, choose to work with no one from her or his group, then that student probably had not increased her or his empathy. However, if the student had already wanted to work with two or three other group members, even though this number did not increase, students showed that they would see a benefit in working with some group members again.

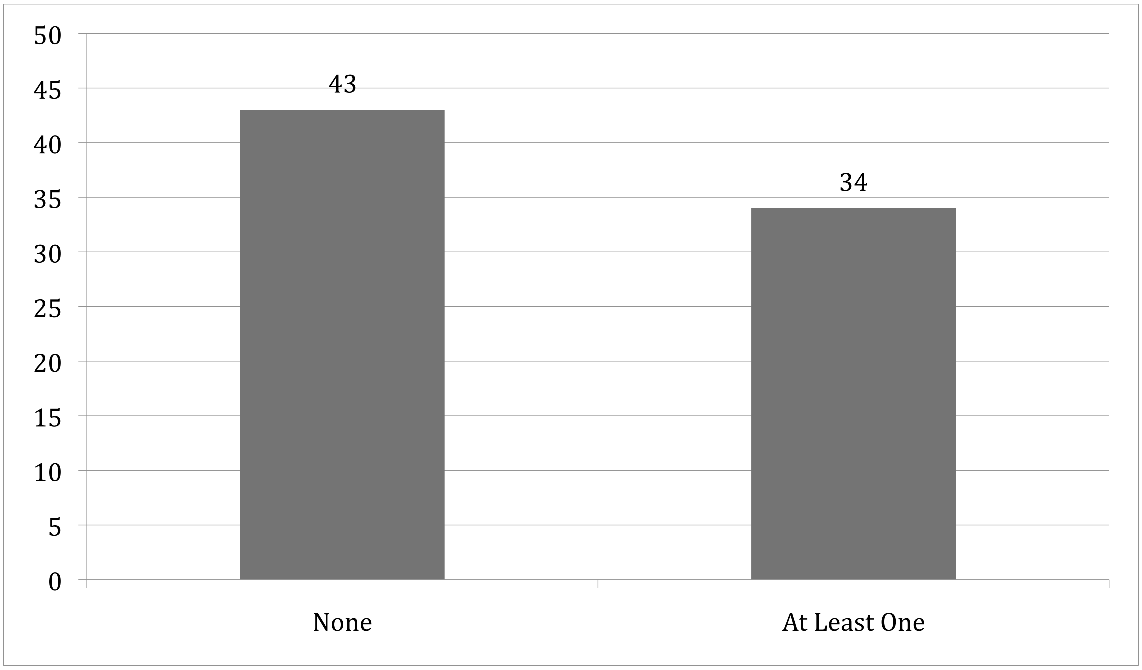


**Figure 5: Number of Group Members Students Would Choose to Work with Again for Those Who Did Not Change the Number of Students with Whom They Would Choose to Work**

Figure 5 shows that 43 students out of the 155 students who participated in the curriculum would choose to work with none of their group member again. By combining these two pieces of data, it becomes clear that, after planning a scientific investigation with a group of their peers, the number of students who would be chosen by their peers to be in their group again would be the same for 70% of students (107 students). The number of students who would increase the number of people with whom they would work increased for 48% of students (73 students). Only 2% of students (3 students) decreased the number of people with whom they would work.

**Finding 4: Positive views of peers were maintained or increased for 74% of students (*n* = 155).**

After students completed their investigations, they reflected on how their own empathy towards their peers in the group had changed over the course of the activity. Students completed the sentence stems, "Before this activity, I thought that (Group Member's Name) was __________. After this activity, I think he or she is ___________." I asked students to write descriptive terms that explained how they felt when they thought of this person. I also reminded students that they could write that they did not know anything about the student before the activity. Each student gave between two and four responses depending on their group size. Table 12 depicts the changes in feelings of the group members, as determined by analyzing if each of the statements that students wrote were positive, negative, or indifferent.

**Table 12: Changes in Feelings Toward Group Members**

| Negative Change | No Change | Positive Change |
| --- | --- | --- |
| Indifferent → Negative | Negative → Negative | Negative → Indifferent |
| Positive → Negative | Indifferent → Indifferent | Indifferent → Positive |
| Positive → Indifferent | Positive → Positive | Negative → Positive |

For example, one student wrote, "Before this activity, I thought that Jacob was nice and worked hard. After this activity, I think he is what I thought before." This student's view of her group member was positive before the curriculum and remained positive even after the implementation of the entire curriculum. After determining how the feelings each student had toward their group members had changed, I determined how students' views toward their peers changed over the course of the activity.

Table 13 clarifies the terms that students used to help me to determine if the views students had toward their group members were positive, indifferent, or negative.

**Table 13: Phrases Showing the Views Students Have Toward Group Members**

| Negative | Indifferent | Positive |
|---|---|---|
| • Not Helpful<br>• Not Productive<br>• Over-Ruling<br>• Goof-Off<br>• Distracting/Distracted<br>• Annoying<br>• Mean<br>• Rude<br>• Weird | • Quiet<br>• I Don't Know<br>• Shy<br>• O.K.<br>• A Positive Phrase Paired with a Negative Phrase:<br>o Example: Smart but lazy. | • Cool<br>• Nice<br>• Hard Working<br>• Helpful<br>• Contributing<br>• Good Student<br>• Smart<br>• Fun<br>• Good Ideas |

Figure 6 shows the changes in students' perceptions toward other students in their groups.

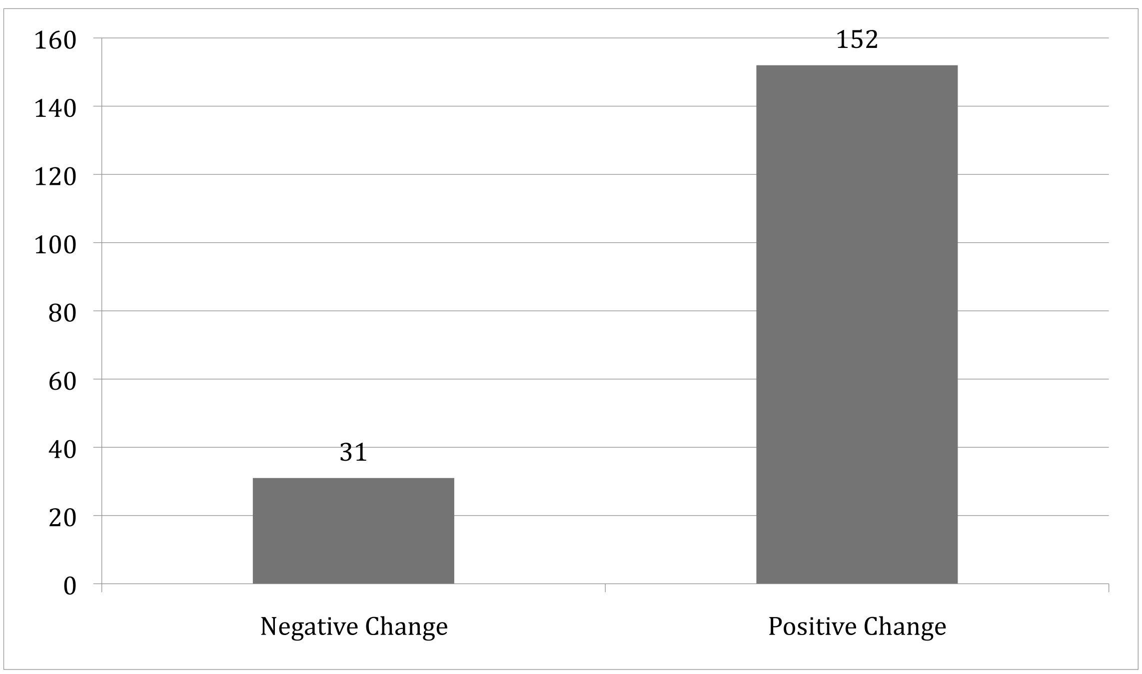


**Figure 6: Changes Students Had in Their Views Toward Group Members**

Although many comments showed a change in the ways students view their group members, 276 (n=466) of the comments made by students showed that no change occurred in the way they view their peers. However, a large majority of these were positive views that remained positive. A majority of students had a positive view of their group members when entering the group, and working with these group members only served to solidify their views. Figure 7 illustrates the number of each type of comment made by students that stayed the same after the activities.

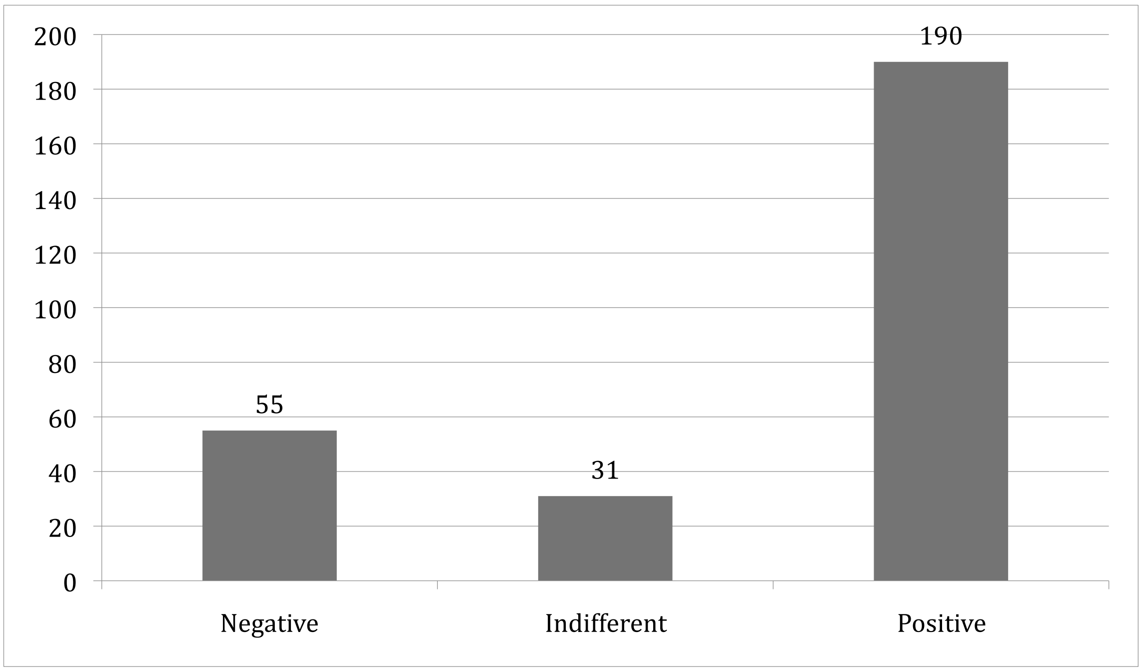


**Figure 7: Types of Comments Made By Students Whose Views Did Not Change**

The data shows that 66% of students who started with a negative view towards their peers had gained a positive view towards their peers by the end of the activity. Further, 63% of students who began the activity with an indifferent view of their peers ended the activity with a positive view of their peers. On the other hand, 12% of students who originally had a positive view of their peers ended the activity with an indifferent or negative view of their peers and 6% of students who had an indifferent view of their group members had a negative view at the end of the activity. As shown in

Figure 7, a large majority of students gained a more positive view of their group members than those who developed a more negative view of their group members. While a large group of students had a positive change in the way they view their peers, a much smaller group had a negative change in the way they view their peers, which will be explored on in the fifth finding.

Overall, 349 of the 466 (76%) comments that students made about their group members either increased in the positive direction (from negative to indifferent, negative to positive, or indifferent to positive) or stayed positive.

**Overall Goal: Students will be more empathetic towards their peers.**

**Finding 5: Students became more empathetic towards the students in their group.**

While not all students had a positive change in the way they viewed their peers, most students showed that they had a greater understanding of the academic and social contributions made by their peers. These students were better able to address both the strengths and weaknesses their peers brought to academic group work making them more empathetic toward their peers. This requires students to go beyond preconceived notions they had about their peers based on superficial experiences or on the reputations of their peers. Below are four examples that show how students' perceptions of their group members have changed since the beginning of this activity.

***Example 1: The Class Clown and the High-Achievers***. Larry transferred to Surf Street Middle School at the beginning of the school year from another middle school in the district. From the first day of school, Larry established himself in class as a "funny" student who often disrupted the class with jokes and made light of every situation. As the teacher, I always knew that Larry took his schoolwork seriously and earned high grades, but after reading the surveys that were completed by Larry's group members, I realized that not all students knew this about him.

One student in Larry's group, a young man who did not sit by Larry or interact with him often at school wrote on his post survey, "Before this activity, I thought that Larry was a slacker. After this activity, I think that he is fun and enjoyable." While this student did not indicate an increased value for Larry's academic ability, his statement suggests that he gained an appreciation for Larry that he did not previously have. Another student in Larry's group, a high-achieving female student who takes her schoolwork extremely seriously wrote, "Before this activity, I thought that Larry was not a good student. After this activity, I think he has good ideas and is really good at contributing to the group." This student had the preconceived notion that Larry did not take school seriously and wanted to distract other students as much as possible. After the implementation, she understands that, although Larry displayed a relaxed demeanor, he had a lot to contribute to her understanding.

Two students in Larry's group went from seeing him as the class clown to seeing him as a valuable member of their group. Both of these students stated that they would not have chosen Larry to be in their group before this activity but would now choose to have him in their group again.

***Example 2: The Introvert and the Extrovert***. Liz, a student who spent most of her lunch periods in the library, had a few friends in her science class, but rarely interacted with people outside of her group of close friends. Spencer, a skateboarding enthusiast, had a large group of friends in his science class and was considered to be very popular at Surf Street Middle School. I had never seen Spencer and Liz interact during the science class that they had together prior to the implementation of the *What's Your Idea?* curriculum.

On the post-implementation survey, Spencer wrote, "Before this activity, I thought that Liz was really shy. After this activity I think that she is smart and fun to work with." Liz wrote, "Before this activity, I thought that Spencer was rude, obnoxious, and bad. After this activity, I think that he is hysterical!" While it seems as though Spencer was indifferent towards Liz before the activity, it is clear that now he has a positive view of her. While Liz may still be shy, Spencer now has a greater understanding of other aspects of Liz's personality. Liz, on the other hand, had a very negative perception of Spencer. Liz's ideas about Spencer are very similar to how many less "popular" students reported what they thought about more "popular" students in their pre-implementation surveys. It seems that the prosocial attitudes and increased conceptual understandings between students led to intersubjectivity that caused students to be more empathetic towards each other. However, the way Liz's views changed is also similar to how many other students in her social circle changed toward their peers in Spencer's social circle as well. All students gained a more complex perception of their peers and were better able to describe multiple aspects of their personalities after having a first-hand experience of planning an investigation with these peers.

***Example 3: The Egotistical High-Achievers.*** Neal, the student discussed at the beginning of this paper, was a high-achieving student who did not get along with many of his peers. Neal stated that he was smarter and more capable than his peers. On the post-implementation survey, one student in Neal's group, Tyler, wrote, "Before this activity, I thought that Neal was really bossy. After this activity, I think he is still pretty bossy." Neal wrote, "Before this activity, I thought that Tyler was annoying. After this activity, I still think he is annoying." Even after working in a group with each other, Tyler and Neal still do not see each other as valuable group members.

Another student, Randy, wrote, "Before this activity, I thought that Neal was going to be overruling. After this activity, I think he is a good contributor and lets everyone share their ideas." Neal wrote, "Before this activity, I thought that Randy was a slacker and mean. After this activity, I think he is a good worker and kind." While it is clear that not all students had a radical change in their perspective of their group members, many students, as shown in this example, have completely shifted the ideas they have about their peers. While Tyler still does not have a positive impression of Neal and Neal does not have a positive impression of Tyler, the relationship between Neal and Randy has moved beyond the preconceived notions that they had of each other before this activity.

Neal's group helped me to realize that although all students in a group interact with all of the same students as each other, not all of them have the same views of their group members. In most groups there were multiple perspectives expressed about an individual student. I have accepted the fact that it would be impossible for the *What's Your Idea?* curriculum to cause every student in one of my classes to have a positive view of every other member of the class. However, I think that it is possible that the curriculum can provide an opportunity for every student to interact with their peers in a way that allows them to develop a realistic view of their peers and provides an opportunity to challenge stereotypes and preconceived identities.

***Example 4: The Past Altercation***. In the first month of school, a group of Mexican-American students, including a girl named Lydia, were standing together near the front of Surf Street Middle School during lunch. A group of three white girls walked by them and one of them, Frankie, yelled, "La Migra" so that the group of Mexican-American girls could hear her. The girls in the group of Mexican-American girls were visibly offended. As some of the Mexican-American girls went to confront Frankie and her friends, the administration intervened. The administrators of Surf Street Middle School worked to calm the upset and angry Mexican-American girls and suspended Frankie from school for a day. A group of Mexican-American students meet with the counselor at Surf Street Middle School on a regular basis to discuss issues related to cultural differences on campus. The counselor told me three weeks before implementing this curriculum that many students were still angry with Frankie and saw her as a racist.

Months later, Frankie and Lydia were randomly placed in the same group to participate in the *What's Your Idea?* curriculum. Frankie and Lydia completed the activity without any negative incidents. On the post-implementation survey, Frankie wrote, "Before this activity I thought that Lydia was named Karla. After this activity, I think she is chill. I like her." Frankie also said that she would choose to work with Lydia again. It is clear that Frankie did not even know the name of one of the girls who she had so horribly offended months earlier, but after working with her to plan an investigation she felt comfortable enough with her to work in a group with her again. Hopefully, this experience has helped Frankie to realize that the people she does not know have a lot to offer to her own experiences. Perhaps this experience will influence Frankie to avoid stereotyping other people based on their ethnicities or races.

Lydia wrote on her post-implementation survey, "Before this activity, I thought that Frankie was not gonna get along with me well. After this activity, I think that she is very nice and sweet and friendly and fun to be around." Lydia was under the impression that Frankie was not type of person with whom she could never work productively in a group. After working together to plan an investigation, Lydia realized that Frankie should not be defined by the insensitive comment that she made. It is my hope that Lydia might be able to help her friends realize that Frankie, who made an ignorant comment, may not be a racist but made an immature mistake when she yelled out an insensitive comment to them.

**Summary of Findings**

Figure 8 shows the number of students who met each of the goals of the curriculum. Throughout the implementation of the *What's Your Idea?* curriculum, 67% of students were able to relate the findings of their scientific investigation to something in their own lives or something outside of the classroom. Additionally, 97% of students used the ideas of their peers to plan and implement a scientific investigation. Finally, 74% of students increased the empathy they had for their group members.

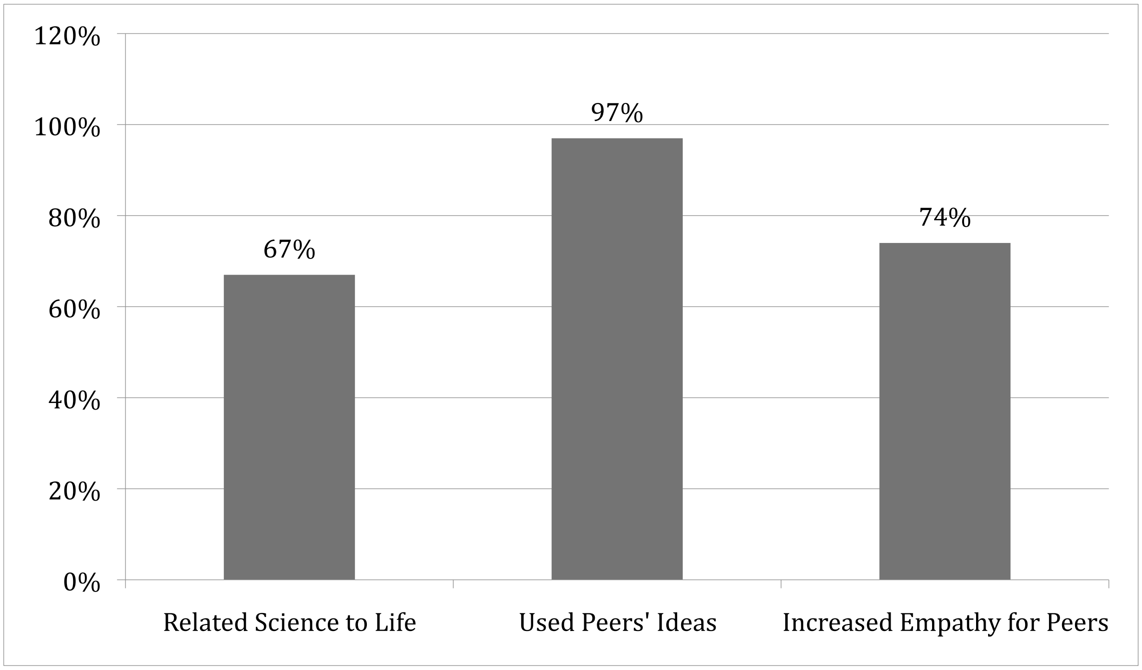


**Figure 8: Percent of Students Meeting the Curricular Goals**

## Summary and Discussion

The overall goal of the *What's Your Idea?* curriculum was for students to become more empathetic towards their peers as shown in the third, fourth, and fifth finding. Based on the data, students who participated in the *What's Your Idea?* curriculum were able to relate the topic they investigated to their own lives. The data also shows that students who participated in the *What's Your Idea?* curriculum used the ideas of their peers to plan a scientific investigation. In addition, the data shows that students who participated in the *What's Your Idea?* curriculum had an increased empathy for their group members. After students participated in the *What's Your Idea?* curriculum, they were able to use a combination of their own ideas and the ideas of their peers to plan an investigation to answer a scientific question and then relate the answer to this scientific question to their own lives. Students who participated in the *What's*

*Your Idea?* curriculum increased the number of their peers with whom they would choose to work and had a more positive view of their peers after completing the curriculum.

By using an inquiry-based approach supported by scaffolded reflecting on group processes, students were able to interact with their peers in a way that they have rarely had the opportunity to do previously. Students were given a guided-inquiry activity and asked only to plan an investigation that answered a question related to forces. Since this was the only requirement, students were expected to make decisions during every activity in the curriculum. Students were also expected to share their ideas with their peers and use their own ideas along with the ideas of their peers to plan and implement their investigation. Combining an inquiry-based approach with reflective group processing was extremely successful because students were presented with multiple opportunities to share and implement their ideas. All students, while participating in the *What's Your Idea?* curriculum participated in a reflective group process and successfully completed an inquiry-based investigation in a group of their peers. By promoting collaboration within an inquiry-based classroom, and carefully scaffolding that collaboration, students had an opportunity to revise their previous understandings not only of the content, but of each other and of themselves.

# CHAPTER VIII. CONCLUSION

Since I began teaching, I have struggled to find ways to encourage students to interact with each other in a way that helps them learn and grow from the ideas of their peers. My hope in implementing the *What's Your Idea?* curriculum was that students would begin to realize that each of their peers has something to contribute to each student's learning. I learned several things about teaching science during my implementation of the *What's Your Idea?* curriculum. The implications of the curriculum had an effect both on how I understand the ways students learn and the ways I teach. I found that by giving students an opportunity to reflect on their group's process in planning and implementing an inquiry science investigation, students gained a better understanding of their peers.

While I have always needed to adjust lesson plans throughout the day to meet the needs of different students, the *What's Your Idea?* curriculum caused me to think critically about every aspect of each activity and the impact it had on student learning. For this reason, throughout the implementation, I changed the questions on the handouts to elicit responses from students that answered the question I intended. When I was not using this curriculum and students misinterpreted questions, I would rephrase the question but often had to wait a year until I was able to see if the new question elicited the responses I intended. With the *What's Your Idea?* curriculum, each question that students answered facilitated a reflective process that could have an effect on each student's final ideas in regards to her or his peers. For this reason, I needed to ensure that each question elicited the response that would help in this reflective process. There was urgency in asking the right questions and this required me to be very flexible in adjusting what the questions asked. For example, I originally gave students a pre-implementation survey question that asked them to list the students with whom they would choose to work. A few students listed their friends who were not in their class, so I needed to quickly clarify the question because their answers would not be useful for my data collection. I never predicted that students would misinterpret that question so I needed to be flexible in adjusting the question in order to elicit responses that would help me collect data.

In addition, since the *What's Your Idea?* curriculum consisted of implementing an inquiry-based activity that gave students an opportunity to explore a question that was important to them, I needed to be flexible in the time I allowed students to complete each activity. I needed to consolidate and split activities over class periods based on the time and effort it took students to complete each activity.

The *What's Your Idea?* curriculum also helped me think about how to effectively teach science. The curriculum showed me that by giving students the opportunity to explore topics important to them they were more motivated to complete the investigations than they had been when they were assigned a question to answer. While this was not extremely surprising, I was surprised by the amount of time students took to complete the investigation. It seems that when I assign a question students are more likely to rush through answering it. When it is their own question that they are answering, they do not seem to rush through the process. As an inquiry-based curriculum, *What's Your Idea?* gave students the opportunity to make decisions and adjust their decisions after seeing the consequences of what they chose to implement. This process gave students a more realistic portrayal of how scientists work. Students needed to work in a group to adjust their procedures until their question had been answered, just like professional scientists. This conclusion supports Zemelmen's (2005) finding that students learn best when participating in authentic experiences.

In addition to learning about myself as a teacher, the *What's Your Idea?* curriculum also helped me better understand how students learn both about science and about how students interact with their group members. I realized that students are capable of changing their perceptions of their peers through working with these peers and participating in a reflective group process. Social justice in the classroom, where every student has the opportunity to contribute to the learning of other students, is possible as Delpit (1988) stated, and was essential in creating a community where all students could succeed during my implementation. Middle school students are also capable of using the ideas of their peers, coupled with their own ideas to plan a scientific investigation that answers a question that is important to the group. This conclusion is contradictory to Krajacik (1998), Jeong's (2004), and Kirschner (2006) findings that students at the middle school level had difficulty asking relevant scientific questions that are essential to inquiry learning. However, these researchers have also focused on classrooms where the inquiry is unguided or minimally guided. It seems, after the implementation of this curriculum, that if middle school students are given the proper intellectual and social support, they can thrive in an inquiry-based setting. For instance, if students are asked to participate in a reflective group process while residing in a classroom that encouraged them to ask questions and explore their ideas, they will have a better ability to learn from and use the ideas of their peers in conducting an inquiry-based investigation.

Throughout the implementation of the *What's Your Idea?* curriculum, I also came to some unexpected conclusions. I found that, compared to other laboratory activities, when students are asking their own questions, as they did in this inquiry activity, they ask less about how an assignment is graded. Students seemed to be more focused on understanding how to answer the question they asked and less concerned with if I, as the teacher, approved of their answer.  Students seemed motivated to adjust their investigation so that they understood it, using their past ideas to form new understandings. This supports Bransford's (2000) research that people construct new knowledge and understandings based on what they already know and believe. As students went through the investigative process, they gained knowledge that further helped their investigation (Brophy, 1998).

I was also surprised to find that when students performed their investigation, they asked more questions about science rather than just writing down their conclusions and putting the assignment away. While all students found an answer to their question, most students continued to make up new investigations with the rest of their materials and the time we had left in class. The inquiry-based collaborative classroom environment seemed to motivate students to ask more questions about science.

The success I had in my classroom led me to think about what I would do differently when I next implement the curriculum. First, I would perform an activity using the *What's Your Idea?* curriculum a few times throughout the year. By implementing it at the beginning of the year students would have a better idea of other students in the class. Then, by implementing it again near the middle of the year students would work with a group of people with whom they may not have interacted.

By doing the curriculum more often it should only serve to break down more barriers between students.

In addition, I would also add an activity where students would present the information they found in their activity to the class. This way, all students in the class would be able to see what conclusions their peers drew in different groups. Also, students in each group would have another opportunity to contribute to the entire group. For instance, if one member of the group did not contribute as much as other members but was willing to take on a large role in the group presentation, that student may be seen as being more valuable to the group than before.

**Suggestions for Future Implementations**

While I am convinced that the *What's Your Idea?* curriculum was successful in my eighth grade science classroom, it needs to be implemented on a wider spectrum to discover whether and how it is successful for a wider variety of students. Eighth grade teachers throughout the state of California would be able to implement the curriculum as it is during their unit on forces and motion using the state standards. If the *What's Your Idea?* curriculum is implemented in different geographic settings, it would be more apparent how the curriculum is taken up in schools with different demographics from Surf Street Middle School.

In addition, I would be interested to see if the *What's Your Idea?* curriculum could be adapted to the curriculum at the elementary and high school levels. Doing this would help me to see if implementing this curriculum in different grade levels helps provide success in breaking down social barriers that exist in all levels of education. I would also be interested to see if the *What's Your Idea?* curriculum could be adapted to fit the curriculum of other content areas. Further, implementing this curriculum in content areas other than science can be done to see if it is as successful when students are planning an investigation into social studies, math, language arts, or physical education.

## Importance of Educational Research

Through the implementation of the *What's Your Idea?* curriculum, I also realized the importance of educational research in my classroom. As I become a more experienced teacher, educational action research enhances my experience by helping me to systematically implement and examine my own teaching practice. In order to enhance the teaching profession, educational research needs to occur in the classroom so that a constant feedback loop between education theory and educational practice is established. If anyone is going to enact change on a state or national level, that person needs to know what is actually occurring in the classroom. Educational research is one avenue for giving professionals this insight.

**APPENDIX**

# What's Your Idea?

## Supporting Middle School Science Students in Developing Empathy Through Group Reflections During Guided Inquiry

By: Samantha Greenstein

# Appendix Table of Contents

# Section I: Introduction

## List of Introduction Materials:

Letter to Teachers

Theoretical Framework for Teachers

# Letter to Teachers

*What's Your Idea?* is an inquiry-based unit for teaching students how to reflect on the ideas of their group members in order to increase their empathy towards their peers. The approach is intended to improve students' understanding of empathy. It is also intended to increase students' inquiry skills and to work towards a more socially just classroom by giving every student a voice. Students are encouraged to journal their own ideas and then share those ideas with their group. Group members then work together to decide on the ideas that work best to find answers to their inquiry investigation. Although this curriculum was specifically developed for a forces unit in a California 8$^{th}$ grade science classroom, it can be adapted for any middle school science unit where students are conducting inquiry.

While time constraints and a lack of resources in the middle school science classroom often deter teachers from implementing inquiry-based activities, these activities allow students to be introduced to multiple standards while also developing investigation and experimentation skills. Both the science content standards and the science skills standards need to be at the forefront of the implementation of this curriculum in order for students to meet all California state standards.

The *What's Your Idea?* curriculum is organized into several sections: an overview, eliciting prior experience, activities, and formal assessments. In the second section, an overview of the curriculum appears along with the California eighth grade standards in science that are addressed in the curriculum. Section three describes the initial activities that prepared students for participating in the curriculum. Section four describes all of the activities of the curriculum along with a lesson plan for each activity. The entire curriculum takes about three to four weeks to implement in a block scheduled classroom. The final section provides concluding activities that allow students to express what they have learned during the implementation of the curriculum.

It is my hope that through the implementation of this curriculum your students will be able to empathize with their peers while improving their inquiry skills.

# Theoretical Framework for Teachers

*What's Your Idea?* is an inquiry-based learning curriculum. This means that students are actively engaged in a project where they are required to ask a question that is important to them and then work towards answering this question by planning an investigation with their peers. To foster this type of curriculum it is important to understand the research on which it is based.

I. Classroom Learning Environment (Bransford, 2000)
   a. Learner-Centered Environment: the teacher seeks information about what the students know and builds on their existing knowledge.
   b. Knowledge-Centered Environment: a focus on concepts and inquiry skills important to science helps foster a scientific environment focused on ideas and evidence for ideas.
   c. Assessment-Centered Environment: teachers use formative assessments to provide students constant feedback and opportunities to revise work.
   d. Community-Centered Environment: teachers create a safe place for students to express ideas and listen and learn from each other.

II. Inquiry in the Classroom (NRC, 2000)
   a. Learner engages in scientifically oriented questions.
   b. Learner gives priority to evidence in responding to questions.
   c. Learner formulates explanations from evidence.
   d. Learner connects explanations to scientific knowledge.
   e. Learner communicates and justifies explanations.

III. Guided Inquiry (Suchman, 1961)
   a. Students should be able to answer the following questions:
      i. What is the purpose of the investigation?
      ii. What type of data would be the most useful?
      iii. What is the best way to organize and display the data?
      iv. What evidence does the data set provide?
      v. Do the results support the hypothesis?
      vi. What conclusions can be made from the data?
      vii. How well does the conclusion fit the data collected?

# Section II: Overview of Activities

**List of Overview Materials:**

Sample Letter of Consent
Inquiry Overview
Overview of the Curriculum
Standards in the Curriculum
Sample Project Timeline

# Sample Letter of Consent

(To be used if this curriculum is implemented for research purposes.)

Dear Parents,

As your child's science teacher, I continue to find innovative approaches to improve the ways in which students learn science. I am working on a curriculum development study that will include the activities we already do in class along with activities that are designed to improve the communication skills of students in their science lab groups.

When your child participates in this project he or she will be taking time to reflect on the ideas of her or his classmates in regards to scientific concepts. It is my hope that these reflections will encourage students to learn from the ideas of their peers in addition to the ideas they learn from their own observations of science in class. If a student chooses not to participate in this project, he or she will still be required to complete the normal school work; I simply will not use her or his work or reflection responses in my study. A student's decision not to participate in this study will in no way affect her or his grade or relationship with the school or me.

During this study students may be videotaped, tape recorded, or interviewed. These recordings will never be shown in a public forum. At the conclusion of this project the raw data will be destroyed. In addition, students' written responses may be used as examples. If you have any questions or concerns about this activity, please feel free to contact me using the information below. Thank you for your help.

Sincerely,
Samantha Greenstein

If you agree to your student participating in this study, you do NOT need to return this form.
[ ] I do not give permission for my student to participate in this study.

Child's Name (please print) ______________________________________

Parent Signature ________________________________ Date __________

# Inquiry Overview

**Indicators that a classroom environment is inquiry-based:**

- Science lessons are concept-driven and reflect scientific practices.
- Students actively engage in science investigations.
- Students engage in a range of inquiry activities.
- Students manipulate science materials to investigate a scientific problem.
- Teachers facilitate students' understanding through divergent questioning strategies.
- Teachers are responsive to students' questions and comments.
- Students use evidence to discuss and explain their understandings from scientific investigations.
- Students produce oral and written reports that present the results of their scientific inquiries.
- Students work in cooperative learning groups.
- Teacher taps into students' prior knowledge of science concepts to design and modify future investigations.
- Teacher incorporates instructional strategies that are consistent with inquiry-based science.
- Teacher makes connections to real-world applications of scientific concepts.
- Teacher uses assessments to guide what to teach next.
- Teacher uses a variety of assessment tools, including performance and embedded strategies.

(The Science Education for Public Understanding Program, 2007)

# Overview of the Curriculum

Throughout the entire 3-4 week unit students are learning about forces during their science class and they will be engaging in science inquiry skills while reflecting on the interactions they have with their group members. This unit was developed on inquiry learning and integrating science inquiry skills with the social issues that arise in middle school group work.

| Science Lessons | Science Inquiry Skills | Process of Activities |
|---|---|---|
| Activity 1: Eliciting Prior Knowledge | What do you already know about forces? | Do the activity on your own. |
| Activity 2: Finding a Problem | What do you want to know about forces? | Share your ideas with your group. |
| Activity 3: Developing a Procedure | How are you going to answer this problem? | Discuss your ideas with your group. |
| Activity 4: Making a Data Table | How are you going to record your data? | Decide on the best idea or combine ideas as a group. |
| Activity 5: Analyzing the Data | What does your data mean? | Implement your group's idea. |
| Activity 6: Drawing Conclusions | What is the answer to your question? | Reflect on the process. |
| Activity 7: Assessing What Was Learned | What did you learn about forces? | How have your ideas about your group members changed? |

# Standards in the Curriculum

| California State Science Standards (8th Grade): Forces[1] | California State Science Standards: Investigation and Experimentation | National Science Education Standards: Scientific Inquiry (Grades 5-8)[2] |
|---|---|---|
| **8.2. Unbalanced forces cause changes in velocity.**<br><br>b. When an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces.<br><br>c. When the forces on an object are balanced, the motion of the object does not change.<br><br>d. Identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.<br><br>e. When the forces on an object are unbalanced the object will change its motion (speed up, slow down, change direction).<br><br>f. The greater the mass of an object the more force is needed to achieve the same change in motion. | **8.9. Scientific progress is made by asking meaningful questions and conducting careful investigations.**<br><br>Students should develop their own questions and perform investigations.<br><br>a. Plan and conduct a scientific investigation to test a hypothesis.<br><br>b. Evaluate the accuracy and reproducibility of data.<br><br>c. Distinguish between variable and controlled parameters in a test.<br><br>e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables. | **Abilities Necessary to do Scientific Inquiry:**<br><br>• Identify questions that can be answered through scientific investigations.<br><br>• Design and conduct a scientific investigation.<br><br>• Use appropriate tools and techniques to gather, analyze, and interpret data.<br><br>• Develop descriptions, explanations, predictions, and models using evidence.<br><br>• Think critically and logically between evidence and explanations.<br><br>• Recognize and analyze alternative explanation sand predictions.<br><br>• Communicate scientific procedures and explanations. |

[1] California Department of Education. (1998) *Science content standards for California Public Schools*. Retrieved June, 5, 2010 from www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf.

[2] *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (2000). Center for Science, Mathematics, and Engineering Education. Washington, D.C.: National Academy Press.

# Example Timeline of Project

This is a rough timeline that you could use to implement this curriculum. Feel free to adapt it to fit the needs of your students. Worksheets, surveys, and activity instructions are included in the next section.

**Week One:**

- Activity 1: Eliciting Prior Knowledge
  - Pre-Implementation Survey #1: What do you already know about forces?
  - Pre-Implementation Survey #2: What roles will your group members play?

- Activity 2: Finding a Problem
  - Finding a Problem Facilitation Worksheet
  - Finding a Problem Group Interactions Reflection

**Week Two:**

- Activity 3: Developing a Procedure
  - Developing a Procedure Facilitation Worksheet
  - Developing a Procedure Group Interactions Reflection

- Activity 4: Making a Data Table
  - Making a Data Table Facilitation Worksheet
  - Making a Data Table Group Interactions Reflection

- Activity 5: Analyzing the Data
  - Analyzing the Data Facilitation Worksheet
  - Analyzing the Data Group Interactions Reflection

- Activity 6: Drawing Conclusions
  - Drawing Conclusions Facilitation Worksheet
  - Drawing Conclusions Group Interactions Reflection

**Week Three:**

- Activity 7: Assessing What Was Learned
  - Post-Implementation Survey #1: What do you know about forces now?
  - Post-Implementation Survey #2: What roles did your group members play?

# Section III: Activities and Materials

**List of Activities Materials:**

# Overview of Goals and Activities

Throughout these activities students will work in a randomly assigned group of 3-5 students. The grouping of students should remain the same throughout the entire unit. All activities are intended to help students meet the following goals:

- Goal #1: Students ask a question about force and then relate the answer they find to something relevant to their own lives outside the classroom.
- Goal #2: Students use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces.
- Goal #3: Students reflect on their peers' ideas to increase their empathy.

**Activity One: Eliciting Prior Knowledge**

- Students will journal the ideas they have about forces and about their role and the roles of their peers when working in a group.

**Activity Two: Finding a Problem**

- Students will journal questions they have about forces and will discuss their questions with their group members. Groups will decide on one question they will investigate.

**Activity Three: Developing a Procedure**

- Students will journal their ideas about how to implement a procedure to answer the question they asked. Groups will work to write a procedure to implement.

**Activity Four: Making a Data Table**

- Students will draw a data table in their journal. Groups will pick a data table that will be most useful to use when implementing the procedure.

**Activity Five: Analyzing the Data**

- Students will analyze data and journal their ideas on their own and then, through discussion with their group, will further their analysis.

**Activity Six: Drawing Conclusions**

- Students will journal their individual answers to their initial question about forces from Activity Two. Through discussion with their group they will solidify their conclusions.

**Activity Seven: Assessing What Was Learned**

- Students will journal the ideas they now have about forces and about their role and the roles of their peers when working in a group.

# Activity One: Eliciting Prior Knowledge
## Lesson Plan

**State and National Standards:**
California 8.2.b. When an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces.
California 8.2.c. When the forces on an object are balanced, the motion of the object does not change.
California 8.2.d. Identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
California 8.2.e. When the forces on an object are unbalanced the object will change its motion (speed up, slow down, change direction).
California 8.2.f. The greater the mass of an object the more force is needed to achieve the same change in motion.

**Objectives:** Students will journal the ideas they have about forces and about their role and the roles of their peers when working in a group.

**Curriculum Goals:** Students reflect on their peers' ideas to increase their empathy.

**Procedure:**
1. Explain to students that scientists regularly work with other people in order to further their research and understanding of scientific concepts.
2. Inform students that they will be completing a survey asking them to specify who they prefer to work with in the class and why they prefer to work with those people.
3. Distribute Pre-Implementation Survey #1 to students and allow them time to complete the survey.
4. After students turn in the survey, group students as you feel best suits your classroom.
5. After students learn who the members of their group are, explain that people in a group are constantly playing different roles. Provide a list of possible roles that people may play in a group but make it clear that this list may be missing some roles that people may play.
6. Distribute Pre-Implementation Survey #2 to students and allow them time to complete the survey.

**Assessment:**
1. Pre-Implementation Survey #1 Answers
2. Pre-Implementation Survey #2 Answers

# Pre-Implementation Survey #1

1. What do you think of when you hear the word “Force”?

2. Who in this class do you prefer to work with? Why?

3. Who in this class do you prefer not to work with? Why?

4. What do scientists do? Do you think that you are a scientist? Why or why not?

# Pre-Implementation Survey #2

| Name of Current Group Member | What role do you think this person will play in the group? (Leader, Motivator, etc.) | What do you think are the strengths that this person will bring to your group? |
|---|---|---|
| You: | | |
| | | |
| | | |
| | | |
| | | |

# Roles of Group Members

1. **Encourager**: attempts to motivate the team.
2. **Praiser**: shows appreciation to other students.
3. **Cheerleader**: gets others to show appreciation.
4. **Gatekeeper**: makes sure everyone is participating.
5. **Coach**: helps others understand what is going on.
6. **Question Commander**: asks if anyone has questions.
7. **Checker**: makes sure everyone understands.
8. **Taskmaster**: keeps the group on task.
9. **Recorder**: writes down group decisions and answers.
10. **Reflector**: summarizes what has been done.
11. **Task Captain**: makes sure everyone is on task.
12. **Materials Monitor**: gets and cleans up supplies.

Adapted from: Kagan, S. (1992.) Cooperative Learning (2nd ed.). Resources for Teachers: San Juan Capistrano.

# Activity Two: Finding a Problem
## Lesson Plan

**State and National Standards:**
California 8.9.a. Plan and conduct a scientific investigation to test a hypothesis.
National Science Education Standards: Identify questions that can be answered through scientific investigations.

**Objectives:** Students will journal the ideas they have about forces and about their role and the roles of their peers when working in a group.

**Curriculum Goals:** Students ask a question about force and then relate the answer they find to something relevant to their own lives outside the classroom.

**Procedure:**
1. Explain to students that they will be asking a question in regards to forces today that they want answered.
2. Ask students to think about experiences they have had with forces. Remind students that they encounter forces everyday (when playing sports, driving a vehicle, riding a bike, etc.)
3. Distribute the "Finding a Problem" worksheet. Ask students to answer questions number two. Students may ask more than one question.
4. After students have had sufficient time to write down their questions, ask students to share their ideas with their group. Instruct students that each group member should have a full minute to share her or his idea before moving to the next group member.
5. Ask students to answer question number three as their group members are talking.
6. Instruct group members to discuss and decide on the question they would like to investigate as a group. Have students answer question number four.
7. Distribute the "Finding a Problem Group Reflection Sheet" and have students fill it out. Instruct students to think about what they accomplished as a group and what each group member contributed. If necessary, show students the "Roles of Group Members" handout.
8. Record observations of student groups using the "Group Observation Checklist."

**Assessment:**
1. Group Observation Checklist
2. Finding a Problem Worksheet
3. Finding a Problem Group Reflection Sheet

**Date:** ____________

# Group Observation Checklist

(Empty space can be used for notes, check marks, or tally marks.)

**Group (Circle)** **1** **2** **3** **4** **5** **6** **7** **8**

| Group Member | | | | |
|---|---|---|---|---|
| **1.** Listens quietly to the other group members. | | | | |
| **2.** Waits for the speaker to finish before speaking. | | | | |
| **3.** Makes comments and submits ideas that are on topic. | | | | |
| **4.** Disagrees with others opinions without getting angry. | | | | |
| **5.** Tries to meld his ideas with other ideas. | | | | |
| **6.** Encourages other group members. | | | | |
| **7.** Asks questions when they don't understand another group member. | | | | |
| **8.** If the group has a problem, the student takes part in the problem solving process. | | | | |
| **9.** If a specific group role is assigned, he stays on task. | | | | |
| **10.** Keeps the group on track with the time allotted for the activity. | | | | |

# Finding a Problem

1. On your own, list some questions you have about forces.

2. While listening to your group members, write down any questions that they have that are of interest to you. Why is this question interesting?

3. Discuss the questions that your group members (or you) had that you are interested in investigating. Write down the question you will investigate (you may combine questions if it is appropriate).

# Finding a Problem Group Interactions Reflection Sheet

Think about how your group worked together today while finding a problem to answer.

Fill in the following chart with your observations of how everyone contributed to the group.

| Name of Current Group Member | What role do you think this person played in the group today? (Leader, Motivator, etc.) | What do you think are the strengths that this person showed in your group today? |
|---|---|---|
| You: | | |
| | | |
| | | |
| | | |
| | | |

1. Who had the best idea of the day?

2. What was the idea?

3. Why did you think the idea was the best idea of the day?

# Activity Three: Developing a Procedure and Making a Data Table

## Lesson Plan

**State and National Standards:**
California 8.9.a. Plan and conduct a scientific investigation to test a hypothesis.

National Science Education Standards: Design and conduct a scientific investigation. Communicate scientific procedures and explanations.

**Objectives:** Students will journal their ideas about how to implement a procedure to answer the question they asked. Groups will work to write a procedure to implement and then work to develop a data table where they can record the data.

**Curriculum Goals:** Students use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces.

**Procedure:**
1. Distribute all materials for students except for one item of your choosing that is essential for students to actually complete the investigation.
2. Distribute the "Developing a Procedure" worksheet.
3. Instruct students to work on their own to develop a procedure that will answer the research question their group has asked.
4. While students are recording their procedure, ask them to keep the following questions in mind: What is the purpose of your experiment? What variable are you testing? What is your control? How many trials will you conduct? How will you record the data?
5. After students have had sufficient time to write down their procedures, have students share their ideas with their group. Instruct students that each group member should have a full minute to share her or his idea before moving to the next group member.
6. Ask students to answer question number three.
7. Instruct group members to discuss and decide on the procedure they think would best answer their question. Have students answer question four.
8. Follow steps 3-7 for the "Making a Data Table Worksheet."
9. Distribute the "Developing a Procedure and Making a Data Table Group Reflection Sheet." Instruct students to think about what they accomplished as a group and what each group member contributed. If necessary, show students the "Roles of Group Members" handout.
10. Record observations of student groups using the "Group Observation Checklist."

**Assessment:**
1. Group Observation Checklist
2. Developing a Procedure Worksheet
3. Making a Data Table Worksheet
4. Developing a Procedure and Making a Data Table Group Reflection Sheet

# Developing a Procedure

1. What question will your group be investigating?

________________________________________

________________________________________

________________________________________

2. On your own, write a step-by-step procedure that you can use in your investigation.

1. ________________________________________
2. ________________________________________
3. ________________________________________
4. ________________________________________
5. ________________________________________
6. ________________________________________
7. ________________________________________
8. ________________________________________
9. ________________________________________
10. ________________________________________

3. Listen to the procedures of your group members. Combine the procedures into the procedure your group will use.

1. ________________________________________
2. ________________________________________
3. ________________________________________
4. ________________________________________
5. ________________________________________
6. ________________________________________
7. ________________________________________
8. ________________________________________
9. ________________________________________
10. ________________________________________

# Making a Data Table

1. On your own, draw a data table that your group can fill in during your investigation.

2. Look at the data tables that your group members produced. Combine the data table into a data table your group will use.

# Developing a Procedure and Making a Data Table Group Interactions Reflection Sheet

Think about how your group worked together today while developing a procedure and making a data table. Fill in the following chart with your observations of how everyone contributed to the group.

| Name of Current Group Member | What role do you think this person played in the group today? (Leader, Motivator, etc.) | What do you think are the strengths that this person showed in your group today? |
|---|---|---|
| You: | | |
| | | |
| | | |
| | | |
| | | |

1. Who had the best idea of the day?

2. What was the idea?

3. Why did you think the idea was the best idea of the day?

# Activity Four: Collecting the Data
## Lesson Plan

**State and National Standards:**
California 8.9.a. Plan and conduct a scientific investigation to test a hypothesis.
California 8.9.c. Distinguish between variable and controlled parameters in a test.

National Science Education Standards: Use appropriate tools and techniques to gather, analyze, and interpret data.

**Objectives:** Students will follow the procedure they developed in Activity 3 and record data that will help answer the question they asked in the data table they developed.

**Curriculum Goals:** Students use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces.

**Procedure:**
1. Distribute the "Lab Write-Up" worksheet.
2. Inform students that they will be implementing the procedure they developed last class and will record the data in the data table they developed.
3. Tell students how much time they have to complete their investigation.
4. Encourage students to make changes that will help their investigation better test their question and tell students that they must discuss any changes with every member of the group. If group members disagree about a change, they can complete the procedure both ways and record the data in two separate data tables. They can then decide which data to use when analyzing their data.
5. Have students complete the "Title," "Problem," and "Hypothesis" portions of the lab write-up. The hypothesis should be written in the "if-then" format.
6. Give students time to implement their procedures.
7. Once students have completed their procedures and recorded the data that they need, have them complete the "Materials," "Procedure," and "Results" portions of the lab write-up and remind students that these portions should describe exactly what was used, completed, and recorded.
8. Record observations of student groups using the "Group Observation Checklist."

**Assessment:**
1. Group Observation Checklist
2. Lab Write-Up Worksheet

Name: ___________________

Date: ____________________

## _____________________________ Lab Report

**Problem:**

_______________________________________________________________

_______________________________________________________________

**Hypothesis:**

If_____________________________________________________________

then___________________________________________________________

**Materials:** ______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

**Procedure:**

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

**Set-Up:**

**Data:**

**Analysis:**

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

**Conclusion:**

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

# Activity Five: Analyzing the Data and Drawing Conclusions
## Lesson Plan

**State and National Standards:**
California 8.9.a. Plan and conduct a scientific investigation to test a hypothesis.
California 8.9.b. Evaluate the accuracy and reproducibility of data.
California 8.9.e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

National Science Education Standards: Use appropriate tools and techniques to gather, analyze, and interpret data. Develop descriptions, explanations, predictions, and models using evidence. Think critically and logically between evidence and explanations. Recognize and analyze alternative explanations.

**Objectives:** Students will analyze data and draw conclusions and journal their ideas on their own and then, through discussion with their group, will further their analysis and conclusions.

**Curriculum Goals:** Students use their own ideas along with the ideas of their peers to design an experiment to answer a question the group has about forces.

**Procedure:**
1. Distribute the "Analyzing the Data and Drawing Conclusions" worksheet.
2. Instruct students to work on their own to answer the analysis and conclusion questions about their investigation.
3. After students have had sufficient time to answer the analysis and conclusion questions, have students share their ideas with their group. Instruct students that each group member should have a full minute to share her or his idea before moving to the next group member.
4. Ask students to answer question number three on the worksheet.
5. Instruct group members to discuss and decide on answers that would best analyze and an answer that would best conclude the questions and have students record these answers on their lab write-up.
6. Distribute the "Analyzing the Data and Drawing Conclusions Group Reflection Sheet" and have students fill it out. Instruct students to think about what they accomplished as a group and what each group member contributed. Show students the "Roles of Group Members" handout.
7. Record observations of student groups using the "Group Observation Checklist."

**Assessment:**
1. Group Observation Checklist
2. Analyzing the Data and Drawing Conclusions Worksheet
3. Analyzing the Data and Drawing Conclusions Group Reflection Sheet

# Analyzing the Data and Drawing Conclusions

1. What question did your group investigate?

2. Answer the following questions on your own:

   a. **Analysis**: What does the data you collected during this investigation show you? (For example, which result was the lowest and which result was the highest?)

   b. **Conclusion**: Using the data you collected as an example, what answer do you have for the problem you stated at the beginning of this investigation?

3. Discuss the above questions with your group and write the answers you would like to record on your lab write-up.

# Analyzing the Data and Drawing Conclusions Group Interactions Reflection Sheet

Think about how your group worked together today while analyzing your data and drawing conclusions. Fill in the following chart with your observations of how everyone contributed to the group.

| Name of Current Group Member | What role do you think this person played in the group today? (Leader, Motivator, etc.) | What do you think are the strengths that this person showed in your group today? |
|---|---|---|
| You: | | |
| | | |
| | | |
| | | |
| | | |

1. Who had the best idea of the day?

2. What was the idea?

3. Why did you think the idea was the best idea of the day?

# Activity Six: Assessing What Was Learned
## Lesson Plan

**State and National Standards:**
California 8.2.b. When an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces.
California 8.2.c. When the forces on an object are balanced, the motion of the object does not change.
California 8.2.d. Identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
California 8.2.e. When the forces on an object are unbalanced the object will change its motion (speed up, slow down, change direction).
California 8.2.f. The greater the mass of an object the more force is needed to achieve the same change in motion.

**Objectives:** Students will journal the ideas they now have about forces and about their role and the roles of their peers when working in a group.

**Curriculum Goals:** Students reflect on their peers' ideas to increase their empathy.

**Procedure:**
1. Inform students that they will be completing a survey asking them to reflect back on their experience conducting their investigation as a group.
2. Distribute Post-Implementation Survey to students and allow them time to complete the survey.

**Assessment:**
Post-Implementation Survey

Name:_______________________________

# Post-Implementation Survey

1. Before this activity, whom in your group would you have picked to be in your group? Please use names.

2. After this activity is there anyone in your group who you would choose to work with again? Please use names.

3. For each member of your group, fill in the following sentence:
   - Before this activity, I thought that ______________ was ________________
     ______________________________________________________________.
     After this activity, I think he or she is _______________________________
     ______________________________________________________________.
   - Before this activity, I thought that ______________ was ________________
     ______________________________________________________________.
     After this activity, I think he or she is _______________________________
     ______________________________________________________________.
   - Before this activity, I thought that ______________ was ________________
     ______________________________________________________________.
     After this activity, I think he or she is _______________________________
     ______________________________________________________________.
   - Before this activity, I thought that ______________ was ________________
     ______________________________________________________________.
     After this activity, I think he or she is _______________________________
     ______________________________________________________________.

4. How did your group come up with ideas?

5. What did you learn about science during this activity?

6. How did the activity relate to your own life or something outside of the classroom?

7. Do you think you are a scientist?  Why or why not?

## REFERENCES


Banks, J., Cochran-Smith, M., & Moll, L. (2005). Teaching diverse learners. In L. Darling-Hammond & J. Bransford (Eds.) *Preparing teachers for a changing world: What teachers should learn and be able to do*. San Francisco: Jossey-Bass.

Basu, S.J. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*(3), 466-489.

Bourdieu, P. (1973). Cultural Reproduction and Social Reproduction. In Brown, R. (Ed.), *Knowledge, education and cultural change*. (56-69). London: Tavistock Press.

Bransford, J. (2000) *How people learn: brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Brobeck, K. (2006). Spanning the achievement gap. *Ideas in Action*. Retrieved October 11, 2009, from http://peabody.vanderbilt.edu/x7098.xml.

Brophy, J. (1998). *Failure syndrome students. ERIC digest 98* (2): 2-6.

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review 31* (1): 21–32.

California Department of Education. (1998) *Science content standards for California public schools*. Retrieved on November 10, 2009 from http://www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf.

California Department of Education and California Department of Public Health (2003). *California healthy kids survey*. Retrieved on November 12, 2009, from www.californiahealthykids.org.

California Department of Education and California Department of Public Health (2008). *California healthy kids survey*. Retrieved on October 9, 2009, from www.californiahealthykids.org.

*California focus on physical science* (2007). Woodland Hills, CA: McGraw Hill Glencoe.

*California focus on physical science* (2008). Boston, MA: Pearson Prentice Hall.

*California focus on physical science* (2007). Evanston, IL: McDougal Littell.

Cole, J. D. (1990). Towards a theory of peer rejection. In S. R. Asher & J. D. Coie (Eds.), *Peer rejection in childhood* (365-401). New York: Cambridge University Press.

Delpit, L. (2006). *Other people's children: Cultural conflict in the classroom* (2nd ed.). New York: The New Press.

Delpit, L. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Educational Review*, *58*(3), 280-298.

Driver, R., & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. *School Science Review, 67*(240), 443-456.

Erikson, E.H. (1963). *Childhood and society*. New York: Norton.

French, D. C. (1988). Heterogeneity of peer-rejected boys: Aggressive and nonaggressive subtypes. *Child Development*, *59*, 976–985.

Haberman, M. (1991). The pedagogy of poverty versus good teaching. *Phi Delta Kappan*, *73*(4), 290-294.

Harms, N., & Yager, R. E. (1981). *What research says to the science teacher, Vol. 3*. Washington, DC: National Science Teachers Association.

Harry, B. & Klinger, J. (2007). Discarding the deficit model. *Educational Leadership, 64*(5), 16-21.

Hassard, J. (2005). *The Art of Teaching Science.* New York: Oxford University Press.

Hehir, T. (2007). Confronting Ableism. *Educational Leadership, 64*(5) 9-14.

*Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (2000). Center for Science, Mathematics, and Engineering Education. Washington, D.C.: National Academy Press.

*Interactions in Physical Science: California Edition* (2007). Armonk, NY: Herff Jones.

Jensen-Campbell, L.A., Adams, R., Perry, D.G., Workman, K.A., Furdella, J.Q., & Egan, S.K. (2002). Agreeableness, extraversion, and peer relations in early adolescence: Winning friends and deflecting aggression. *Journal of Research in Personality*, *36*, 244-251.

Jeong, H., Songer, N. B., & Lee, S. (2007). Evidentiary competence: Sixth graders' understanding for gathering and interpreting evidence in scientific investigations. *Research in Science Education, 37*(1), 75-97.

Jonkmann, K., Trautwein, U., & Ludtke, O. (2009). Social dominance in adolescence: The moderating role of the classroom context and behavioral heterogeneity. *Child Development*, 80(2), 338-355.

Juvonen, J., & Wentzel, K. R. (1996). Social motivation: Understanding children's school adjustment. Cambridge, U.K.: Cambridge University Press.

Kirschner, P., Sweller, J., Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Research*, 41(2), 75-86.

Kohlberg, L. (1984). *The psychology of moral development: Essays on moral development (Vol. II).* San Francisco: Harper & Row.

Krajacik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J. (1998). Inquiry in project-based science classrooms: Initial attempts by middle school students. *The Journal of the Learning Sciences, 7,* 313-350.

Lease, A. M., Kennedy, C. A., & Axelrod, J. L. (2002). Children's social constructions of popularity. *Clinical Child and Family Psychology Review*, *10,* 335–351.

Michie, G. (2007). Seeing, hearing, and talking race: Lessons for white teachers from the four teachers of color. *Multicultural Perspectives*. *9*(1), 3-9.

Millstone, R. (2010). *Optimizing the Orchestration of Resemiotization with Teacher "Talk Moves": Model of Guided-Inquiry Instruction in Middle School Science*. Unpublished doctoral dissertation, University of California at San Diego.

National Research Council. (1996). *The national science education standards*. Washington DC: National Academy Press.

*The nation's report card: Science 2005*. Washington, DC: National Center for Educational Statistics.

Novick, R. (2010). Telling is compelling: The impact of student reports of bullying on teacher intervention. *Educational Psychology*. *30*(3), 283-296.

Pascarella, J. (2004). Why Teach in Urban Settings? In S. Steinerg & J. Kincheloe (Eds.) *19 Urban Questions*. New York: Peter Lang.

Rosebery, A. S., Warren, B., & Conant, F. R. (1992). Appropriating scientific discourse: findings from language minority classrooms. *The Journal of the Learning Science. 2*(1), 61-94.

Ryan, A. M., & Patrick, H. (2001). The classroom social environment and changes in adolescents' motivation and engagement during middle school. *American Educational Research Journal, 38*(2), 437-460.

Shymansky, J. A., Kyle, W. C., & Alport, J. M. (1983). The effects of new science curricula on student performance. *Journal of Research in Science Teaching, 20*(5), 387-404.

Suchman, J.R. (1961). Inquiry training: Building skills for autonomous discovery. *Merrill-Palmer Quarterly, 7*, 147-169.

Tatum, B.D. (1997). *Why are all the black kid sitting together in the cafeteria? And other conversations about race.* New York: Basic Books.

Trautmann, N., Avery, L., Krasny, M., Cunningham, C. (2002, April). *University science students as facilitators of high school inquiry-based learning*. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, LA. Retrieved October 4, 2009, from http://ei.cornell.edu/pubs/CEIRP_NARST_02.pdf

Villegas, A.M. & Lucas, T. (2007). The culturally responsive teacher. *Educational Leadership*, *64*(6), 28-33.

Vygotsky, L.S. (1962). *Thought and language* (E.H.G. Vakar, Trans.). Cambridge, MA: MIT Press.

Vygotsky, L.S. (1997). *Educational psychology* (R. Silverman, Trans.). Boca Raton, FL: St. Lucie.

Vygotsky, L.S. (1980). Interaction between learning and development. In M. Cole, et al. (Eds.), *Mind in society*, (79-91). Cambridge, MA: Harvard University Press.

Weiss, I. R. (1987). *Report of the 1985-1986 National survey of science and mathematics education*. Research Triangle Park, NC: Research Triangle Institute.

Wiggins, G., & McTighe, J. (2006). *Understanding by design* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Wolf, S. J., Fraser, B. J. (2008). Learning environment, attitudes and achievement among middle-school science students using inquiry-based laboratory activities. *Research in Science Education, 38,* 321-341.

Wood, C. (2007). *Yardsticks: children in the classroom*. Turner Falls, MA: Northeast Foundation.

Youth Learn Initiative (2003). *An introduction to inquiry-based learning*. Retrieved October 19, 2009, http://www.youthlearn.org/learning/approach/inquiry.asp