AUTONOMY SUPPORT: TEACHER BELIEFS AND PRACTICES DURING STEAM INSTRUCTION AND ITS INFLUENCE ON ELEMENTARY STUDENTS

by

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ABSTRACT

Autonomy is the sense that one has control over one’s actions within an environment or that one has some degree of choice over his or her own life. Autonomy support involves an individual who is in a position of authority, (e.g., parent, teacher, coach), taking the perspective of another (e.g. student, child), acknowledging their feelings, and providing opportunities for choice (Reeve, Jang, Carrell, Jeon & Barch, 2004; Roth, Assor, Kanat-Maymon, & Kaplan, 2007). STEAM is a curricular framework that emphasizes project-based learning through the integration of science, technology, engineering, arts and mathematics.

This study examined the beliefs and practices of third to fifth grade teachers around student autonomy during STEAM instruction. To meet this purpose, a qualitative analysis of teachers’ epistemological beliefs, classroom instructional practices, and use of autonomy-supportive practices during STEAM instruction was conducted. Next, an examination of students’ perception of and response to autonomy-supportive practices during instruction was conducted using student survey data and coded observations. A belief/practice gap was found among teachers as reported beliefs and teacher practices were qualitatively different. Hierarchical linear modeling was used to examine the impact of student’s perceptions of autonomy, attitudes toward STEAM and teacher’s autonomous practices on student engagement. Student perceptions of autonomy and attitudes towards STEAM were found to be significant predictors of student engagement by homeroom, but teacher’s autonomous practices were not at the student level or the teacher level.
DEDICATION

This dissertation is dedicated to everyone supported me through the journey of my program and the creation of this manuscript. I owe a special debt to my father, who passed away before this journey was complete and my mother, who has been my biggest cheerleader throughout this entire process. Your strength and courage made all the difference. I achieved this long-term dream with you and because of you and you are loved.
# LIST OF ABBREVIATIONS AND SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>α</td>
<td>Cronbach’s index of internal consistency</td>
</tr>
<tr>
<td>$M$</td>
<td>Mean: the sum of a set of measurements divided by the number of measurements</td>
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<tr>
<td>$N$</td>
<td>Sample size</td>
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<tr>
<td>$BIM$</td>
<td>Behavior and Instructional Management Scale</td>
</tr>
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<td>$EBI$</td>
<td>Epistemological Beliefs Inventory</td>
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<tr>
<td>$p$</td>
<td>$p$-value: probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value</td>
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<tr>
<td>$PIS$</td>
<td>Problems in Schools Questionnaire</td>
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<tr>
<td>$SD$</td>
<td>Standard deviation</td>
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<tr>
<td>$S-STEM$</td>
<td>Student Attitudes Toward Science Technology, Engineering and Mathematics Scale</td>
</tr>
<tr>
<td>$STEAM$</td>
<td>Science, Technology, Engineering, Arts and Math integrated instruction</td>
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<tr>
<td>$TASC-Q$</td>
<td>Teacher as Social Context Questionnaire</td>
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<td>$&lt;$</td>
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CHAPTER ONE
INTRODUCTION

Background

With the move to Common Core and Next Generation Science Standards, teachers are being asked to facilitate instruction in ways that engage students in critical thinking and problem-solving tasks on a consistent basis (Palinscar, 2013). However, for many practicing teachers, this can require extensive retraining and a paradigm shift that can be difficult or tedious. This same shift in the curriculum requires students to develop skills that are based on specific practices that support life-long learning (Palinscar, 2013). For example, students are being asked to think more critically and flexibly while developing the ability to work collaboratively and communicate their reasoning to others. In order to facilitate this shift in teacher practices and explore the impact on students, it is important to examine which practices are commonly used in today’s classrooms and what instructional models can facilitate and support this shift to increased critical thinking and problem solving. This also creates a unique opportunity to explore teacher practices in context and the impact of those practices on students as both groups grapple with higher standards and greater expectations.

Student autonomy is a student’s sense of control over that student’s own learning and environment. Research has shown that instructional environments which support student autonomy have the potential to boost student engagement (Stefanou, Perencevich, DiCintio & Turner, 2004; Reeve, Jang, Carrell, Jeon & Barch, 2004). The goal of this examination is to
determine the types of instructional practices used most frequently by elementary teachers to support student autonomy during learning and its impact on student engagement. In addition, it is important to examine the impact of their current instructional practices on students’ engagement with the curriculum, their motivation for learning complex content, and their self-efficacy.

This paper focused on some of the limitations in the literature related to teacher practice, autonomy support, and student engagement. First, most researchers agree that autonomy supportive practices enhance student engagement and achievement (Assor, Kaplan & Roth, 2002; Stephanou et al., 2004; Furtak & Kunter, 2012). According to Klem and Connell (2004), elementary students who reported higher levels of teacher support had attendance rates of 97% or higher and higher percentile scores in reading and/or math. Research has also identified factors that tend to cause teachers to use a more controlling style of teaching (Pelletier, Seguin-Levesque & Legault, 2002; Reeve, 2009). These factors include the pressure to meet certain performance standards, comply with a particular curriculum, and/or teachers’ beliefs that their students are non-self-determined. However, there are few studies that examine teachers’ beliefs about student autonomy and their actual classroom practice or how this impacts student engagement within particular content areas at the elementary level, such as STEAM instruction.

Stephanou et al. (2004) proposed 3 distinct types of autonomy support: organizational, procedural, and cognitive autonomy support. Organizational autonomy support includes teacher practices that allow student choice over environmental procedures, such as developing rules, choosing seating arrangement or group members (Stephanou et al., 2004). This encourages student ownership of the environment. Procedural autonomy support includes
teacher practices that offers students choice in how they will present their learning, discuss their wants and handle classroom materials (Stephanou et al, 2004). Cognitive autonomy support includes teacher practices that involves asking students to generate multiple solutions to a problem, asking students to self-evaluate, increased teacher listening time (Stephanou et al, 2004), fostering relevance by explaining the role of the learning content and activity in relation to the student’s personal goals and interests (Assor, Kaplan, & Roth, 2002).

The authors argued that cognitive autonomy support is particularly important for student engagement in higher cognitive processes; however, they did not conduct an empirical study to support these suppositions. In addition, their observational study was conducted with a mostly White, middle class population. As a result, the effect of cognitive autonomy support was not examined in situ, nor did they examine the role of cognitive autonomy support among minority students considered at-risk.

In order to most effectively enhance teaching and learning, it was important to examine both the cognitive and motivational aspects of learning at both the instructor and student level. It was also important to examine whether teachers who report a strong belief in autonomy-supportive practice were actually able to practice it in the classroom. It would also worthwhile to determine whether student’s perception of autonomy and their level of motivation and self-efficacy were higher in classrooms with greater autonomy supportive practices.

**Statement of the Problem**

Much of the research literature supports the idea that teachers’ epistemological beliefs about learning and knowing effect the practices they utilize during their instruction (Dolphin & Tillotson, 2015; Hofer & Pintrich, 1997; Hofer, 2000). This has been specifically researched in areas of language, math and science instruction (Oga-Baldwin & Nakata, 2015;
Cotterall, 1995; Brickhouse, 2015; Kuntze, 2012; Magno, 2011). Most of the studies have mixed results and do not include student perceptions of teacher practice on learning experiences (Nussbaum, Sinatra & Poliquin, 2008; Olafson & Schraw, 2006; Hofer, 2000; Tsai, 2007).

Research literature also supports the notion that autonomy supportive practices have numerous benefits for students and classroom learning environments (Stroet, Opdenakker, & Minnaert, 2013; Reeve & Jang, 2006; Assor, Kaplan & Roth, 2002; Black & Deci, 2000). Among those benefits are a greater sense of purpose for learning, increased engagement with school, higher academic achievement, and a stronger sense of self-efficacy (Assor et al., 2002; Barber & Buehl, 2013; Furtak & Kunter, 2012; Gutman & Sulzby, 2000). While these benefits have been clearly demonstrated, there is limited research that looks at autonomy-supportive beliefs and practices in elementary environments and peer-reviewed work that examines these beliefs and practices within STEAM (Science, Technology, Engineering, Arts, Mathematics) environments among highly diverse student populations is scarce (Quigley & Herro, 2016; Guyotte, Sochacka, Constantino, Walther & Kellam, 2014). The following section will give a brief overview of the literature, and in doing so present a case for the contribution of the proposed study to the field.

Instructional environments that support student autonomy have been shown to boost student engagement and achievement (Assor et al., 2002; Stephanou et al., 2004; Furtak & Kunter, 2012; Reeve et al., 2004). When students feel a sense of autonomy support, they report a greater sense of self-efficacy and increased motivation.

Recently, researchers have begun to examine what precipitates a teacher being autonomy supportive. One potential antecedent is a teacher’s epistemological beliefs (Roth &
Weinstock, 2013). Epistemological beliefs range from objectivist, where truth is considered absolute to relativist, where truth is believed to be constructed. Teachers with a more objectivist (absolute) personal epistemology were perceived by their students to be less autonomy-supportive, while those who were more relativist in their beliefs, were perceived to be more autonomy-supportive.

In addition to teacher’s epistemological beliefs, there are socio-contextual conditions that can lead teachers to be more or less autonomy-supportive (Pelletier, Seguin-Levesque, & Legault, 2002). These conditions or factors include: pressures to comply with curriculum, with performance standards, with colleagues and their perceptions that students are not self-determined or unable to self-initiate.

Regarding student perceptions of autonomy-support, students in grades as low as the 3rd grade have been able to recognize and communicate their perceived autonomy support and are able to distinguish between different types of autonomy-supportive practices (Assor et al., 2002). For students, the best predictors of engagement and feelings about school were clarifying the relevance of learning and the teacher’s ability to suppress criticism or empathize with their students.

**Purpose of the Study**

This study examined teacher beliefs about student autonomy and learning. It also looked at teacher practices related to student autonomy, specifically during STEAM instruction. The purpose was to examine the alignment between teacher beliefs and the instructional practices they use most frequently. In addition, this study looked at student’s perceptions of autonomy support and their engagement during STEAM instruction. The purpose was to support the relevance of autonomy-supportive practices in STEAM
environments for authentic student engagement. Research Questions

Based on the scope of the literature and the purpose of this dissertation, this study proposed the following questions:

Research Question 1: What are elementary teachers’ beliefs about student autonomy and learning in a STEAM-focused environment?

Research Question 2: What is the relationship between teachers’ beliefs about autonomy and their actual classroom practices?

Research Question 3: Are students’ perceptions of autonomy consistent with teachers’ actual classroom practices?

Research Question 4: Does student perception of autonomy, student attitudes about STEAM, and teaching style influence student engagement during STEAM instruction?

Overview of Methodology

The location of this study was purposely selected to allow for examination of autonomy- support in a STEAM-focused environment with students considered at-risk. Park Place (a pseudonym) Elementary is a Title I designated public school serving students in grades preschool through 5 with a STEAM focus in a mid-sized school district in the Southeastern region of the United States. As previously discussed, STEAM is an acronym for Science, Technology, Engineering, Arts and Mathematics. Park Place will be entering their fourth year as a STEAM-designated school during the 2016-17 school year.

Participants

Third through fifth grade teachers were recruited using announcements during faculty meetings. For the purposes of this study, a teacher was defined as anyone considered highly qualified by the school district that provides direct academic instruction at least 70% of the
time. Students in grades 3-5 were recruited through parent letters and class announcements. Teachers and administrators were asked to identify those students who were deemed capable of giving assent and responding to survey questions. Participants did not receive any compensation for participation in this study.

**Procedures and Instrumentation**

Teacher participants were asked to participate in a semi-structured interview, three classroom observations during academic instruction and to complete a battery of survey measures electronically using the Qualtrics platform. Teacher measures explored epistemological beliefs, beliefs around autonomy support, self-efficacy in math, science, and technology and practices related to behavior and management. Student participants were asked to complete a battery of survey instruments using paper and pencil. Student measures explored student perceptions of various types of autonomy support, self-efficacy and engagement in STEAM.

**Analysis**

This study used a mixed-methods design to allow for a more complete picture of the beliefs being identified and practices being observed. A qualitative analysis was conducted on teacher interview transcripts. Using grounded theory (Charmaz, 2006) and metaphor analysis (Tobin & Tippin, 1996), common themes will be identified. In addition, a descriptive analysis was used to code and count autonomy-supportive practices during STEAM instruction across 3 classroom observations per teacher participant. Descriptive analysis using IBM SPSS was run to find means, standard deviations and Pearson correlation coefficients for survey data.

To examine student level data, SPSS was again run to find means, standard deviations and Pearson correlation coefficients. Hierarchical Linear Modeling was used to
test student’s perception of autonomy support as a predictor of self-efficacy, motivation and engagement within classrooms.

**Significance**

This study sought to first reveal the relationships between teacher’s beliefs and practices around student autonomy in STEAM-rich environments for minority students. By examining teacher beliefs and practices around student autonomy, it is hoped that a better understanding of understand teacher factors that enhance or suppress students’ engagement within a STEAM-focused environment could be identified. Secondly, this study sought to determine if student perceptions of autonomy were consistent with teacher practice within STEAM environments and students’ level of motivation and self-efficacy within these settings. This study sought to add to the body of literature around autonomy-support, STEAM, and upper elementary populations.

**Assumptions and Limitations of the Study**

The assumptions of the study were as follows:

1. Teachers are defined as 3rd through 5th grade instructors certified to provide and engaged in providing direct instruction to students on a daily basis.

2. Participants in the study will answer questions truthfully and reflectively.

3. Participants have a desire to work within a STEAM-focused environment and put forth a good effort to engage in STEAM activities.

4. Participants will not make any significant changes to their instructional practices during observations.

5. The researcher is an active participant within this school community and has an established rapport with students and staff.
The limitations of the study were as follows:

1. This study investigated teachers’ beliefs and practices around student autonomy at one school location within one district, which may be difficult to generalize to a larger population.

2. Due to the small teacher sample size, this study was difficult to generalize to a larger population.

**Definition of Important Terms**

The following section is meant to provide an explanation of key terms and their meanings as it relates to the present study. I have chosen terms that best explain the meaning I have determined for this particular study.

*Autonomy*—According to Deci and Ryan (1987), autonomy refers to the ability to choose or “an action that is chosen.”

*Autonomy-Supportive behaviors*—Autonomy-supportive behaviors refer to those behaviors which provide students with opportunities for choice, take into account the student’s perspective, and make learning relevant, while minimizing the use of pressures and demands, usually by a person in authority, such as a teacher (Black & Deci, 2000). These behaviors include: providing choice, allowing for self-directed learning, recognizing the perspective of others and clarifying the relevance of an activity or content (Grolnick, Ryan, & Deci, 1991; Skinner & Belmont, 1993).

*Controlling or Autonomy-suppressing Behaviors*—Controlling behaviors include those teacher behaviors that hinder student autonomy such as suppressing student criticism, engaging students in meaningless tasks, and intruding on students’ work time (Assor et al, 2002).

*Organizational Autonomy Support*—Organizational autonomy support includes teacher behaviors that provide student choice over environmental procedures, such as developing
rules choosing seating arrangement or group members (Stephanou et al., 2004). This encourages student ownership of the environment.

_Procedural Autonomy Support_—Procedural autonomy support includes teacher behaviors that offers students choice in how they will present their learning, discuss their wants and handle classroom materials (Stephanou et al., 2004).

_Cognitive Autonomy Support_—Cognitive autonomy support includes teacher behaviors that include asking students to generate multiple solutions to a problem, asking students to self-evaluate, increased teacher listening time (Stephanou et al., 2004), fostering relevance by explaining the role of the learning content and activity in relation to the student’s personal goals and interests (Assor et al., 2002).

_Epistemology_—Epistemology is a basic theory of knowing or how we believe knowledge is generated (Hofer & Pintrich, 1997; 2000; Kuhn, 2001). Our everyday views occur on a spectrum from objectivist to relativist and include numerous dimensions.

_Expectancy-Value Theory_—Expectancy value theory was originally proposed by Atkinson (1957, 1964) as a way to explain different kinds of achievement-related behaviors. He theorized that achievement behaviors were based on achievement motives, incentive values and expectancies for success. Modern expectancy value theories (Wigfield and Eccles, 1992, 2000) are based on Atkinson’s model and link achievement performance, persistence and choice to individuals’ task value and expectancy-related beliefs within elaborate contextual factors (Eccles, 2004).

_STEAM_—STEAM is a collaborative, cross-curricular framework that integrates science, technology, engineering, arts and mathematics content areas (Yakman, 2008; Guyotte et al., 2014). This framework encourages collaborative planning among teachers and creative,
flexible thinking among students. Due to its project-based nature, students are able to engage in investigations that allow them to follow their own interests, think critically and problem-solve (Blumenfeld, Soloway & Marx, 1991).
CHAPTER TWO
LITERATURE REVIEW

Introduction

This chapter provides a review of the literature which explores the primary areas of importance for this study: teachers’ epistemological beliefs, a general discussion of autonomy, autonomy-supportive and controlling behaviors of teachers, STEAM-focused environments, student intrinsic motivation, and student attitudes towards STEAM. This review of literature demonstrates the need for further study regarding autonomy-supportive teacher practices, particularly within STEAM-focused learning environments at the elementary level.

Epistemological Beliefs

Most individuals have an everyday theory of knowing. In order to explore these different views of knowledge and knowing, many researchers have begun to group these everyday theories under the term “personal epistemology” (Hofer & Pintrich, 1997; Kang, 2008). Hofer (2000) has proposed four dimensions of personal epistemology: certainty, simplicity, source, and justification of knowledge. Views of each of these dimensions lie on a spectrum from objectivist to relativist.

Those who maintain a more objectivist view (Kuhn, 2001) hold a more absolute view of knowledge. They believe that knowledge comes from outside the individual and as a result this knowledge is simple and certain. This means they lean towards self-evident truths and single correct answers acquired from some authority (teachers, textbooks, etc). Those who
maintain a more relativist view (Roth & Weinstock, 2013) hold a more flexible view of knowledge. They believe that knowledge is complex and changing and that the source of knowledge comes from subjective construction by the individual. From this perspective, there are no absolute truths or certainties. Roth and Weinstock (2013) explored teachers’ epistemological beliefs as an antecedent to autonomy-supportive teaching. The premise was that teachers with a more sophisticated or relativistic view of knowing are more likely to believe that multiple perspectives exist and may be more inclined to use autonomy-supportive practices.

On the other hand, teachers with a more absolute, objectivist view of knowing, might expect their students to follow one path to the ‘right’ answer and are more likely to be controlling in their practices. Roth and Weinstock’s (2013) hypothesis was that a teacher’s epistemological beliefs would predict their use of autonomy supportive teaching practices and their findings supported this hypothesis. Students who perceived their teachers to be more autonomy-supportive expressed a greater sense of autonomous regulation and therefore a greater sense of intrinsic motivation. Along with their finding, other researchers have found increased academic achievement, intrinsic motivation, and self-regulated learning (Roth & Weinstock, 2013) among students who perceive their teachers to be autonomy-supportive. One recent study of middle school students did find that students of teachers with more relativistic epistemological beliefs reported that their teachers were more likely to be autonomy supportive (Weinstock, Nussbaum & Glassner, 2006).

There are numerous studies that look at teachers’ epistemological beliefs, however the primary focus of these studies is on teachers as learners, not teachers as practitioners. There are a limited number of studies (Brownlee, Schraw, & Berthelsen, 2012; Kang, 2008; Olafson &
Schraw, 2006; White, 2000; Yang, Chang, & Hsu, 2008) that explore teachers’ epistemological beliefs and its influence on their teaching practices and those that do exist have mixed results. There are few empirical studies that look at in-service teachers’ epistemological beliefs within elementary populations and there is still much debate about whether epistemological beliefs are domain general or domain-specific. Olafson and Schraw (2006) argue that teachers have an epistemological worldview. This worldview represents their collective beliefs about what knowledge is and how it is acquired and this worldview is also consistent across various academic domains. Since elementary teachers are typically trained to teach all subject areas, it is possible that their epistemological views could be consistent across academic domains. Further study of elementary populations could further validate this claim.

It is important to determine the epistemological beliefs of teachers when looking at their classroom practices, because those subconscious beliefs have been demonstrated to affect their actual classroom practice (Ledermann, 1999; Kang, 2008). Because we know that beliefs influence practice, examining current beliefs can aid us in making predictions about the types of practices we may see and help us to determine the types of interventions we may need to develop to support teachers in shifting their beliefs and practices in a more substantial way. By exploring the epistemological beliefs of elementary teachers along with their practice, there is the opportunity to identify in situ those practices which support students’ independence during learning tasks or those which promote rote learning.

**Autonomy**

Autonomy has been defined in several ways. One of the first to conceptualize autonomy was Jean Piaget in his discussion of the goal of education (Kamii, 1982; Kamii, Clark & Dominic, 1994; Tsai, 2007). Within his theory, Piaget describes two types of morality,
autonomy and heteronomy. For Piaget, autonomy was about the ability to self-regulate and to
think for oneself. According to Kamii et al., (1982), autonomy involves being governed by
oneself and is the opposite of heteronomy which is being governed by others. From a
developmental perspective, children should become more autonomous as they grow older and
are able to make more decisions for themselves. However, this seldom happens. According to
Piaget, as discussed by Kamii (1982), this is related to the way that adults interact with
children. Adults who use frequent rewards and punishments reinforce children’s natural
heteronomy while those who exchange points of view with children promote the development
of autonomy. This applies to both parents and teachers.

Within the concept of autonomy, a teacher’s motivating style can be examined on a
dichotomous continuum from highly controlling to highly autonomy supportive (Deci,
Schwartz, Sheinman, & Ryan, 1981). Teachers who are autonomy supportive tend to provide
instruction in a way that identifies, nurtures and develops students’ inner motivation. This
involves activating students’ interests, goals, personal preferences and psychological needs.
Studies with a focus on teachers’ autonomy-supportive practice have demonstrated a positive
impact on student engagement (Black & Deci, 2000; Barber & Buehl, 2013) and motivation
(Furtak & Kunter, 2012; Gutman & Sulzby, 2000; Stephanou et al, 2004).

While most studies have focused on pre-adolescents (Stephanou et al, 2004; Haerens,
Aelterman, Van den Berghe, De Meyer, Soenens, & Vansteenkiste, 2013) to college age
students (Black & Deci, 2000; Langdon et al, 2014), a small number of studies have examined
elementary populations (Gutman & Sulzby, 2000; Assor, Kaplan & Roth, 2002; Oga-Baldwin
kindergartners were more interested and more engaged in a letter writing task when presented
in an autonomy-supportive context than in a controlling context. While this study had a relatively small sample size (n=20), it was the only study present in the literature that specifically focused on minority elementary children considered at-risk and the impact of autonomy-support on their intrinsic motivation.

Assor, Kaplan & Roth (2002) surveyed Israeli students in grades 3-8 to determine if they could differentiate between autonomy-supporting and autonomy-suppressing behaviors. They then examined how these behaviors predicted students’ feelings toward and engagement with their schoolwork. They found that both children and adolescents were able to differentiate between autonomy-supporting and autonomy-suppressing behaviors and that teacher’s behaviors did have an impact on student’s feelings toward and engagement with schoolwork. In particular, they found that two autonomy supportive practices, fostering relevance and suppressing criticism, have a greater effect on student’s sense of autonomy than providing choice. This helps us to understand the importance of broadening the way we think about autonomy-support in classroom contexts. Teacher practices must move beyond simply providing student choice.

While this study surveyed students about their perceptions, there were no observations to examine exactly what the teacher behaviors looked like or how often they occurred. This makes it difficult to determine if a particular degree or amount of autonomy-support is particularly significant for students.

Stephanou et al., (2004) used an observational study to identify various features of autonomy support provided by teachers in their classrooms: (a) organizational autonomy support, (b) procedural autonomy support and (c) cognitive autonomy support. Organizational autonomy support encourages students to take ownership of their classroom environment.
Teacher practices may include allowing students to assist in developing classroom rules or selecting due dates for assignments. Procedural autonomy support encourages students to take ownership of the form in which they present their learning. Teacher practices may include allowing students to choose materials in a class project or how they will demonstrate their mastery of content. Cognitive autonomy support encourages students to take ownership of their actual learning. Examples of teacher practices include but are not limited to: giving students opportunities to find multiple solutions to problems, to be independent problem-solvers, and debate their ideas freely through less teacher-directed talk and more student-directed discussion.

**Expectancy-Value Theory**

Researchers who study motivation have posited many theories to explain how motivation affects persistence, performance and choice. One of the most well-known and long-standing theories is that of expectancy-value theory (Wigfield & Eccles, 2000; Eccles, 2004). Some of the earliest versions of this theory can be found in the work of Atkinson (1957) and Battle (1965; 1966). In their work, they worked to identify motivational determinants of task persistence and academic competence and their relationship to academic achievement. They discussed six motivational determinants: 1) relative attainment value; 2) absolute attainment value; 3) minimal goal level; 4) minimal goal certainty; 5) expectancy for success and 6) combined motivational variables (Battle, 1965; 1966).

According to Wigfield & Eccles (2000) expectancies and values are proposed to be influenced directly by achievement choices, effort persistence and performance. In turn, expectancies and values are proposed to be influenced by certain beliefs which are task-specific. These include one’s ability beliefs, individual goals, and perceived difficulty of task. In addition, in the model proposed by Wigfield and Eccles, a socializer’s beliefs and behaviors
(in this instance, teachers) and a child’s perceptions of a socializer’s beliefs, expectations and attitudes are some of the earliest influencers of a child’s expectations for success and their achievement-related choice. Researchers have found that students who value the content being learned and feel that their needs are being met are more likely to be invested in their own learning, to expend more effort and are more willing to use deep learning and metacognitive strategies (Blumenfeld & Rogat, 2006). This is where autonomy-supportive practices and expectancy-value theory are connected. Teachers help students value what they are learning by making content relevant to their everyday experiences and their community. In addition, by listening to students and allowing students to generate sub-questions of inquiry that allow them to follow their own interests, teachers can acknowledge student’s need for autonomy and recognize their personal interests.

STEAM

A major initiative in current educational reform is centered on Science, Technology, Engineering, and Mathematics (STEM) education (Land, 2013; Yakman & Lee, 2012). Traditionally, these fields have been treated as separate entities, with emphasis on the development of the convergent skills that each of these fields require. More recently, however, decision-makers have recognized that a more integrated framework is needed to make STEM education more appealing to today’s students. One iteration of this integrated framework incorporates the arts and is classified as STEAM (Science, Technology, Engineering, Arts, and Mathematics) (Yakman & Lee, 2012).

There are multiple conceptualizations of STEAM (Yakman, 2008; Guyotte, Sochacka, Constantino, Walther, & Kellam, 2014), however the common theme found in all of them is a collaborative, cross-curricular framework that allows for the integration of content areas and
learning experiences that encourage students to construct, revise and refine their thinking. STEAM encourages collaborative planning and integrated teaching among educators and creative, flexible thinking among students. In addition, the integrative nature of STEAM supports the Next Generation Science Standards (NGSS; Palincsar, 2013) which cut across three primary areas: practices, core concepts, and cross-cutting ideas. For students, the STEAM framework is an opportunity to apply core academic skills or core concepts in meaningful ways through the use of specific science or engineering practices that allow for multiple solutions and innovations. In addition, STEAM can be considered a form of project-based learning. The use of authentic projects allows students to integrate academic skills across subject areas and construct deeper understanding as well as produce projects and/or products that demonstrate their understanding.

While most research discusses the need for STEAM education, there are very few studies that examine the teaching practices utilized during STEAM instruction. In addition, while there are numerous studies that examine the impact of STEM instruction on student attitudes or interest in STEM-related fields, there are fewer studies that specifically examine the impact of STEAM instruction on students’ attitudes or interest in STEAM-related fields.

**Autonomy-Supporting and Controlling Practices of Teachers**

Research has shown that the quality of instructional practices employed by teachers has an impact on students’ engagement with the content (Timostsuk & Jaanila, 2015) as well as their level of achievement (Firmender, Gavin, & McCoach, 2014). Most recently, many states have adopted standards of practice in math (NGA, 2010) and science (NGSS, 2013; Bybee, 2014) as a part of the Common Core. These standards emphasize how students should interact with and engage in learning content related to math and science. There are eight
mathematical practices and eight science and engineering practices (see table 1) which support active student engagement with content. These practices are the processes in which students should be engaged on a regular basis within the classroom.

Table 2.1

<table>
<thead>
<tr>
<th>STEM Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Make sense of problems and persevere in solving them.</td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively.</td>
</tr>
<tr>
<td>3. Construct viable arguments and critique the reasoning of others.</td>
</tr>
<tr>
<td>4. Model with mathematics.</td>
</tr>
<tr>
<td>5. Use appropriate tools strategically.</td>
</tr>
<tr>
<td>6. Attend to precision.</td>
</tr>
<tr>
<td>7. Look for and make use of structure.</td>
</tr>
<tr>
<td>8. Look for and express regularity in repeated reasoning.</td>
</tr>
<tr>
<td>9. Make sense of problems and persevere in solving them.</td>
</tr>
</tbody>
</table>

As discussed by Firmender et al. (2014), many of these practices are grounded in socio-cultural theory and the Vygotskian tradition. This means that learning is taking place through numerous social interactions in which teachers provide scaffolding and students are actively making sense of academic content through exchanges which require student/student and teacher/student interactions. In addition, these practices naturally fit into a STEAM-focused environment in which students are expected to collaborate, generate new ideas and apply skills to novel problems. These practices may be easier to facilitate for some teachers than others, based on their training and level of comfort with the course content.

Teachers who tend to fall on the controlling end of the autonomy spectrum may be less...
comfortable providing experiences which involve these practices and support the development of autonomy within their students. Conversely, teachers who fall on the supportive end of the autonomy spectrum may be more comfortable providing these experiences for their students. It is important to examine the practices of teachers within a STEAM-focused environment to determine if there is a need for intervention or training to better facilitate teacher development and student engagement.

Researchers (Grolnick & Ryan, 1987; Skinner & Belmont, 1987; Kamii et al, 1994; Reeve and Jang, 2006; Reeve & Halusic, 2009) have identified specific behaviors that provide autonomy support for students. Grolnick and Ryan (1987) identified specific behaviors which included offering choice, encouraging self-initiation, minimizing the use of control and acknowledging the feelings and perspectives of others. Skinner and Belmont (1987) expanded on this list of identified behaviors by including the clarification of the relevance of an activity. Teachers who are autonomy-supportive both identify and nurture their students’ interests, needs and preferences by providing them with frequent classroom opportunities by which students can be “self-determined in their learning” (Reeve, Jang, Carrell, Soohyun & Barch, 2004). Reeve and Halusic (2009) identified several strategies which teachers can use to incorporate autonomy-supportive practices into their classrooms. These included but were not limited to: taking the students’ perspective, using non-controlling language, acknowledging students’ thoughts, feelings and goals, and providing the rationale behind given tasks. Reeve & Jang (2006) specifically identified 11 behaviors demonstrated by teachers that can either enhance student autonomy and 11 behaviors that were more likely to suppress student’s sense of autonomy (see table 2).
Table 2.2
*Autonomy Supporting and Autonomy Suppressing Teacher Behaviors*

<table>
<thead>
<tr>
<th>Autonomy-supporting behaviors</th>
<th>Autonomy-suppressing behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time teacher listening</td>
<td>Time teacher talking</td>
</tr>
<tr>
<td>Asking what students want</td>
<td>Time holding/monopolizing learning materials</td>
</tr>
<tr>
<td>Time allowing students to work in own way</td>
<td>Exhibiting solutions/answers</td>
</tr>
<tr>
<td>Time student talking</td>
<td>Uttering solutions/answers</td>
</tr>
<tr>
<td>Seating arrangements</td>
<td>Uttering directives/comands</td>
</tr>
<tr>
<td>Providing rationales</td>
<td>Making should/ought statements</td>
</tr>
<tr>
<td>Offering encouragements</td>
<td>Asking controlling questions</td>
</tr>
<tr>
<td>Offering hints</td>
<td>Deadline statements</td>
</tr>
<tr>
<td>Being responsive to student-generated questions</td>
<td>Criticizing the student</td>
</tr>
<tr>
<td>Communicating perspective-taking statements</td>
<td>Operational definitions</td>
</tr>
<tr>
<td>Specific praise as informational feedback</td>
<td>Praise used as a contingent reward</td>
</tr>
</tbody>
</table>

**Engagement**

Engagement is a multidimensional construct that refers to “the intensity and emotional quality of children’s involvement in initiating and carrying out learning activities.” (Skinner & Belmont, 2003). Typically, it is comprised of three, sometimes four dimensions to include behavior, emotion, cognition and agency (Skinner, Kindermann & Furrer, 2009; Reeve, 2013). In simplest terms, it is a student’s active emotional, behavioral and cognitive involvement in learning activities. Behavioral engagement can be defined as “children’s initiation of action, effort, and persistence on schoolwork” (Skinner, Wellborn & Connell, p.24, 1990). In an autonomy-supportive environment, one should see higher levels of behavioral engagement as students attempt to initiate participation in learning activities, put forth visible effort and persist through challenging or complex tasks. In addition, the nature of a STEAM environment should allow teachers to create rich, interactive projects that allow students to make connections across content areas and see the relevance of their learning in the real world.
Emotional engagement can be defined as a student’s “motivated involvement in learning activities” (Skinner et al., p.9, 2008) and the positive feelings they associate with those activities, such as enjoyment. In a STEAM environment, particularly one which is autonomy-supportive, students’ motivation to participate should be high because the tasks are interesting to students and authentic enough to promote real-world connections.

Cognitive engagement involves the level of thinking skills used by a student (Skinner & Belmont, 1993). These thinking skills tend to include deep processing, critical thinking and elaboration and transfer of learning (Jang, Kim & Reeve, 2016). In an autonomy-supportive environment which incorporates STEAM, there should be opportunities for students to think deeply and critically about what they are learning as they attempt to solve authentic problems. Agentic engagement is the newest dimension to be explored (Reeve, 2013). Agentic engagement can be defined as one’s ability to initiate action to cause one’s environment to be more supportive and need-satisfying (Reeve, 2013; Jang et al, 2016). Within a STEAM environment that is autonomy-supportive, students should be able to articulate their needs to enhance the environment and ensure their success within the environment.

Studies with a focus on autonomy-supportive practice have demonstrated a positive impact on student engagement (Black & Deci, 2000; Barber & Buehl, 2013;) and motivation (Furtak & Kunter, 2012; Gutman & Sulzby, 2000; Stephanou et al, 2004). While most studies have focused on pre-adolescents (Stephanou et al, 2004; Haerens et al., 2013) to college age students (Black & Deci, 2000; Langdon, Schlote, & Melton, 2014), a small number of studies have examined elementary populations (Gutman & Sulzby, 2000; Assor, Kaplan & Roth, 2002; Oga-Baldwin & Nakata, 2015). Gutman and Sulzby (2000) demonstrated that African-American kindergarteners were more interested and more engaged in a letter writing task when
presented in an autonomy-supportive context than in a controlling context. This was the only study present in the literature that specifically focused on minority elementary children considered at-risk. While this study focuses specifically on literacy, there were no identifiable studies that explored how autonomy-supportive contexts impact elementary students’ engagement with STEM or STEAM learning.

The primary focus of this study is to answer the following question: Do teacher practices in a STEAM-focused environment support student autonomy?

Secondary questions are provided at two levels:

**Teacher level**

Research Question 1: What are elementary teachers’ beliefs about student autonomy and learning within a STEAM-focused environment?

Research question 2: What is the relationship between teachers’ beliefs about autonomy and their actual classroom practices?

*Hypothesis:* There is a significant relationship between teachers’ beliefs about autonomy and their actual classroom practice. As demonstrated in the literature, teachers with more relativistic beliefs about knowledge and learning tend to be more autonomy-supportive in their practice (Roth & Weinstock, 2013). STEAM environments are designed to incorporate high interest, project-based activities. Teachers in STEAM environments should employ practices that promote multiple solutions, divergent viewpoints, and student-initiated learning

**Student level**

Research question 3: Are students’ perceptions of autonomy consistent with teachers’ actual classroom practices?
Hypothesis 1: There is a significant relationship between students’ perception of autonomy and teacher’s level of autonomy support. When teachers are autonomy-supportive, the literature has demonstrated that students are able to perceive this support (Assor et al, 2002; Black & Deci, 2000; Greene, Miller, Crowson, Duke, & Akey, 2004) and that these students report increased efficacy and engagement in learning. These findings have primarily been a result of self-reported survey responses. This study will be an attempt to further confirm this relationship through the addition of direct observation of autonomy-supportive practices and student participation in learning.

Research question 4: Does student perception of autonomy, student attitudes about STEM, and teaching style influence student engagement within a STEAM environment?

Hypothesis 1: Student perception of autonomy is related to student engagement. Assor et al. (2002), demonstrated that students as young as 3rd grade are able to perceive autonomy support. Those students who reported higher autonomy support also reported more positive feelings toward learning and greater behavioral and cognitive engagement. Similar patterns have also been found in subsequent studies (Reeve et al, 2004; Stephanou et al, 2004; Jang, Reeve & Deci, 2010). This study is an attempt to determine if this pattern holds true in a high-poverty, STEAM-rich environment.

Hypothesis 2: Student attitudes toward STEAM are related to student engagement, after controlling for student attitudes, within a STEAM environment. Autonomy research has demonstrated that importance of interest on student engagement within autonomy-supportive environments (Katz and Assor, 2007; Gillet, Vallerand, & LaFreniere, 2012). Providing students with choice is only autonomy-supportive and meaningful when the choices incorporate student interest. When choice is contrived and not relevant for students, it does not appear to
enhance student engagement. This study will attempt to validate this claim within a STEAM-rich environment, since these environments tend to create frequent opportunities for high-interest activities.

**Hypothesis 3:** Teaching style moderates the student perception-student attitudes relationship to student engagement. STEAM rich environments create numerous opportunities for high-interest project-based experiences. These experiences however, do not account for teacher practices within those experiences. Research has demonstrated that instructional practices and teacher behaviors have an impact on student practice (Lederman, 1999; Tsai, 2007). This study is an attempt to examine the impact of these practices when utilized within a high-interest, project-based environment focused on STEAM.
CHAPTER THREE

METHODOLOGY

This study occurred in two phases. Phase one explored teachers’ epistemological beliefs and its impact on their classroom practice. Phase two examined student perceptions of autonomy, their attitudes towards STEAM and their classroom teacher’s autonomous practices and how those factors impacted the engagement in school. Current epistemological beliefs research (Hofer, 2001; Brunner, 2006; Blomeke, 2008; Kang, 2008) has demonstrated that teacher beliefs impact classroom learning and outcomes. This research attempted to explore this phenomenon among a population of elementary school teachers, an understudied population, within specific learning contexts.

Method

Introduction

The purpose of this study was to examine elementary teachers’ beliefs and practices around autonomy-support in a STEAM focused environment and its potential impact on student engagement. The location for this study was purposely selected for its focus on STEAM. The teacher participants were recruited because of their role in providing STEAM instruction to their 3rd-5th grade students. The student participants were selected because of their ability to communicate their perceptions of autonomy and their feelings about their learning as demonstrated in the literature (Assor, Kaplan & Roth, 2002).

The following research questions inform this study and the methodology to be
employed: (a) What are elementary teachers’ beliefs about student autonomy and learning within a STEAM-focused environment?; (b) Is there a relationship between teachers’ beliefs about autonomy and their actual classroom practice?; (c) Are students’ perceptions of autonomy consistent with teachers’ actual classroom practices and beliefs?; and (d) does student perception of autonomy, student attitudes about STEM, and teaching style influence student engagement within a STEAM environment? The procedures employed in this study are discussed in this chapter to include a description of the methodological framework, participants and data sources, as well as data analysis and the role of the researcher.

**Mixed Method Design**

This study used a mixed methods design, a methodology that involves collecting both quantitative and qualitative information (Creswell, 2003). A more explicit definition of mixed methods research is “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (Johnson & Onwuegbuzie, p.17, 2004). In addition, Creswell & Plano Clark (p. 5, 2007) states that “mixed methods involve philosophical assumptions that guide the direction of collection and analysis of data and the mixture of qualitative and quantitative data in a single study or series of studies.” The rationale for using mixed methods is to provide a more complete picture of the phenomena being studied since neither qualitative nor quantitative methods can adequately capture the details of the situation. This model consists of a single data collection phase during which qualitative and quantitative data are collected simultaneously. Data for this study included semi-structured interviews, metaphor analysis, survey instruments and classroom observations. By triangulating interviews, metaphor analysis, survey responses and observations, I was able to obtain a more complete picture of the autonomous beliefs and
practices among the identified teachers. In addition, it allowed me to examine student perceptions of teacher practices in situ.

**Background**

Park Place Elementary School, a pseudonym, is a Title I, public elementary school in the southeastern region of the United States. In 2012, they adopted the STEAM curriculum which focuses on science, technology, engineering, arts and mathematics integration. At the time of this study, the school was entering their fourth full year as a STEAM-focused school. Approximately 60% of the teaching staff joined the Park Place team after the initial STEAM training and certification. STEAM programming features unique to the school include a fully-stocked Lego lab, culminating STEAM projects each quarter, and a wide range of community partnerships to include a student organization formed at the local University specifically to support STEAM activities at the school. Student enrollment for the 2016-17 school year was 415 students in grades Prek-5 with the following demographic makeup: 93% African-American; 4% Hispanic; 2% other minorities and 1% white. The school received a grant which allowed 100% of students to receive free breakfast, lunch and a snack each day.

**Participants**

The participants of this study were comprised of 8 upper elementary teachers (3rd-5th grade) and 120 3rd-5th grade students. All eight teachers were female; five were African-American and three were Caucasian. On average, teacher participants had 13.25 years of teaching experience with the fewest number of years being 7 and the greatest being 24. For the number of years teaching at the current school, the average number of years was 9.875 years with two teachers having only 2 years, 5 teachers had 5-15 years and one teacher had more than 20 years at the same school site. Fifty percent of the teachers had an advanced
degree, with one of those being a Ph.D. in Educational Leadership and one teacher was currently working on her master’s degree in curriculum and instruction. Student participants were recruited from the classrooms of the teacher participants.

There were 200 students enrolled in the 3rd through 5th grade classrooms at Park Place elementary. A total of 120, or sixty percent of students from the 3rd through 5th grades returned consent and assent forms. The demographic of the student participants are as follows: 53.3% of student participants were male (n=64) and 46.7% were female (n=56). 33.3% of student participants were in the third grade (n=40); 36.7% were in the fourth grade (n=44) and 30% were in fifth grade (n=36).

Teachers participated in individual semi-structured interviews, completed a group of surveys online using the Qualtrics platform and participated in 3 classroom observations, during instruction. Teachers received a recruitment letter (see appendix) with attached consent form during grade-level meetings. Once consent was obtained, teachers were scheduled for a semi-structured interview at a time that was convenient and did not interfere with their teaching schedule. Once interviews were complete, teachers received a link to the Qualtrics website to complete surveys and scheduled their first observations during instructional blocks. The second and third observations were un-announced. Participation in this study was voluntary.

Students were asked to take home letters and consent forms. Upon the return of consent forms, students were asked to sign assent forms in small groups and completed paper and pencil surveys. To ensure appropriate assent, the form was read aloud to students while they read along and they were given the opportunity to ask any questions they may have had before signing.
Based on a review of the literature (Assor, Kaplan & Roth, 2002; Skinner et al., 2008), upper elementary grade students are developmentally more capable of providing survey responses related to autonomy support and engagement.

**Data Sources**

This study used multiple forms of data to include semi-structured interviews (see appendix), observations using a modified version of the Teaching Dimensions Observation Protocol (Hora & Ferrare, 2014) (see appendix) and a series of teacher and student surveys.

**Teacher measures**

**Semi-structured interviews**

Teachers participated in a semi-structured interview. This interview included obtaining basic demographic information such as: level of education, number of years teaching, grades taught, current grade teaching and number of years in current grade assignment. The next portion of the interview asked teachers to respond to the following prompt in the form of a metaphor, “Teaching is like________________ because__________________________”.

In addition, teachers will be asked a series of questions taken from the Teachers Belief Interview (Luft & Roehrig, 2007) and to describe their understanding of autonomy and its role in student learning. Teachers received the demographic questionnaire and a copy of the interview questions (see appendix) with space to make notes just before the actual interview.

Forty-five minutes to an hour was allotted for each interview. Interviews will be recorded to allow for transcription and coding.

**Surveys**

*Epistemological Beliefs Instrument* (EBI; Chen & Elliott, 2002). EBI was developed as a modified version of Schommer’s 63-item epistemological beliefs questionnaire and includes 4
dimensions: Fixed/Innate Ability, Authority/Expert Knowledge, Certainty Knowledge and Learning Effort/Process. These four dimensions tend to be salient in diverse environments and align with theories and practices commonly discussed in elementary teacher education programs (Duell & Schommer-Aikins, 2001; Kalra & Baveja, 2012). EBI was originally normed on 370 Chinese students enrolled in an Education program. The EBI continues to be used in more recent studies (Oga-Baldwin & Nakata, 2015; Cheng, Chan, Tang, & Cheng, 2009). Cronbach’s alpha values for the four subscales range from .60 to .70, which is more reliable than Schommer’s original scale.

*Problems in Schools Questionnaire* (PIS; Deci, Schwartz, Sheinman & Ryan, 1981).

PIS was designed to assess whether a person in authority leans more toward controlling the behavior of others as opposed to supporting their autonomy. This 32-item measure contains four subscales that represent points along a continuum ranging from a controlling orientation to an autonomy supportive orientation. Cronbach’s alpha for the four subscales demonstrate good internal consistency: highly controlling alpha = .70; moderately controlling alpha = .69; moderately autonomous alpha = .63; and highly autonomous alpha = .76.

*Behavior and Instructional Management Scale* (BIMS; Martin & Sass, 2010). BIMS was designed to measure teachers’ behavioral and instructional management approaches in their classroom. This measure has been found to correlate with the PIS (Deci et al., 1981). The brief 12-item version of this measure will be used. The Cronbach’s alpha for the two subscales are as follows: behavioral management (.77) and instructional management (.77).

*Teacher Efficacy and Attitudes Toward STEM* (T-STEM; FIEI, 2012). T-STEM is a measure developed to assess teacher’s self-efficacy in STEM content and teaching. It also examines their attitudes towards 21st century learning skills and teacher leadership, their use of
instructional practices related to STEM, and the frequency of student technology use within their classrooms. The T-STEM contains five constructs which will be used in this study: personal teaching efficacy and beliefs, teaching outcome expectancy beliefs, STEM instruction, 21st century learning attitudes, and STEM career awareness. The construct reliability levels for elementary teachers (N=218), measured with Cronbach’s alpha are: personal teaching efficacy and beliefs science (.91) and math (.94); teaching outcome expectancy science (.85) and math (.90); STEM instruction (.95); 21st century learning attitudes (.95); and STEM career awareness (.95).

*Teacher as Social Context Questionnaire* (TASC-Q; Belmont, Skinner, Wellborn & Connell, 1988). TASC-Q was developed as a self-report measure to examine three areas of teacher behavior that impact student’s experiences in the classroom: structure, involvement and autonomy support. The subscales for structure and autonomy support will be used for this study.

*Observations*

A modified version of the Teaching Dimensions Observation Protocol (TDOP; Hora & Ferrare, 2014) was used during classroom observations. This instrument used continuous 2-minute observation intervals and provided a list of instructional codes with definitions. Three 50-minute classroom observations were conducted with each identified teacher. This generated 75 two-minute observation intervals per teacher. One observation was announced while the remaining two were unannounced. This protocol (see appendix) was used to capture teacher practices related to teaching methods, student-teacher dialogue, instructional technology, potential student cognitive engagement, and pedagogical strategies. Additional codes were added to the protocol to include indicators of autonomy support. These codes
included student interest, and student choice. The Teaching Dimensions Observation Protocol (TDOP) was used during live observations to record and code classroom interactions. This allowed the data collection to be as non-invasive as possible. The TDOP was developed as a customizable observation protocol to examine the dynamic interactions that occur between teachers and students in classrooms. It included strategies, technology use and potential student engagement. The protocol can be used electronically on a tablet/laptop or paper and pencil. The protocol has been used by numerous researchers in post-secondary settings. This study was an attempt to use this instrument in an upper elementary setting while observing elementary teachers.

**Student measures.**

**Surveys**

*Autonomy-Affecting Teacher Behavior Scale* (Assor et al, 2002). This scale was developed to assess student perceptions of teacher behaviors related to autonomy. This measure was administered to 862 Israeli-Jewish children in grades 3-8. Items related to relevance and choice were originally drawn from the Rochester Assessment Package for Schools (Connell, 1990; Wellborn & Connell, 1987). Cronbach’s alpha for subscales are as follows: providing choice (.75); fostering relevance (.81); allowing criticism (.76); suppressing criticism (.72); intruding (.73) and forcing meaningless and uninteresting tasks (.58). This is one of the only autonomy scales that has been normed on elementary students and has been utilized in modified forms in subsequent studies (Barber & Buehl, 2013; Velayutham, Aldridge & Fraser, 2011).

*Teacher as Social Context Student—Short form (TASC-student short;* Belmont, Skinner, Wellborn, & Connell., 1992). TASC-student was developed as a self-report measure to examine
student perceptions of autonomy within classroom setting. Cronbach’s alpha was originally calculated on a sample of 500 children in grades 3-6 with the following results: involvement (.80); structure (.76); and autonomy support (.79).

*Motivation vs. Disaffection Scale-modified* (Skinner, Kindermann, & Furrer, 2009). This scale was used to measure students’ engagement and/or disaffection with school. More specifically it looked at behavioral and emotional engagement and disengagement. This instrument has been modified to include cognitive engagement. In addition, the structure of items was expanded to include engagement related to math, science and STEAM.

*Student Attitudes Toward STEM (S-STEM) Survey* (FIEI, 2012). S-STEM is used to measure student’s efficacy, attitudes and interests in STEM fields and learning. Additional items will be included to capture arts and design attitudes. The S-STEM Upper Elementary Survey was normed on 799 4th and 5th grade students. Construct reliability levels, as measured by Cronbach’s alpha for each subscale are as follows: math attitudes (.86); science attitudes (.89); technology and engineering attitudes (.84); and 21st century learning attitudes (.86).

**Analyses**

Grounded theory (Charmaz, 2006) and metaphor analysis (Tobin, 1996; Lackoff & Johnson, 1990) were used to identify themes from transcripts of teacher interviews. According to Charmaz, grounded theory methods include “systematic yet flexible guidelines for collecting and analyzing qualitative data to construct theories ‘grounded’ in the data themselves” (p.2). Coding allows one to narrow, sort and make comparisons with other portions of data.

Metaphor (Lackoff & Johnson, 1990) shapes the way we think about ourselves and others, events and experiences. In addition, Tobin (1996) argues that for educators, the
metaphors they use, knowingly or unknowingly, guide much of their actual practice.

Reflection through metaphor and metaphor analysis have been used as tools to understand the beliefs of pre-service teachers (Cassel & Vincent, 2011; Seung, Park, & Narayan, 2011), and science teachers (Csorba, 2015; Tobin, 1996). Analysis of teaching metaphors has been used to examine pre-service teacher’s beliefs about teaching (Csorba, 2015; Cassel & Vincent, 2011) and in-service teacher’s beliefs about math and science learning (Tobin, 1996), as well as a limited number of studies that look at teacher’s epistemological beliefs as predecessor to their autonomous instructional practices (Roth & Weinstock, 2013; Brownlee et al., 2012; Kang, 2008; Olafson & Schraw, 2006; White, 2000; Yang et al, 2008).

Metaphor analysis involved taking the metaphors teachers generated during the semi-structured interviews and highlighting descriptive words and then sorting metaphors into categories that emerge. Categories from a previous study (Cassel & Vincent, 2011) might be: end-product, end-product/process, sample end-product/process, process, overwhelming and unclear were used as a starting point.

In order to obtain an overall picture of the teacher participants, descriptive statistics were run using IBM SPSS and a summary of demographic information from interviews. To determine if there was a significant relationship between teacher beliefs about autonomy and their actual classroom practice, correlations were generated using SPSS. In order to obtain a score for teacher’s actual autonomy-supportive practices during STEAM instruction, an observation protocol was used to record and count autonomy-supportive behaviors.

**Student level**

Initially, descriptive statistics and correlations were run using SPSS to obtain an overall picture of the students included in the study. To determine if there was a relationship
between teacher’s autonomy-supportive practices and student perceptions of autonomy-support, Pearson correlation coefficients were derived. Hierarchical linear modeling (Lee, 2000; Osborne, 1999) was used to determine if autonomy-supportive classrooms were more predictive of student engagement in a STEAM environment. Hierarchical Linear modeling, also known as multilevel modeling, is a statistical methodology used to analyze variance within outcome variables when the predictor variables occur at differing hierarchical levels (Lee, 2000). More specifically, HLM simultaneously examines relationships between and within hierarchical levels of grouped data (Woltman, Feldstain, MacKay & Rocchi, 2012). This allows one to examine variables which are nested within different levels. One example of this is that students within a classroom should share variance according to their common teacher and classroom. This type of analysis allowed me to examine outcomes within context in a way that other analyses would not allow.

**Research Questions and Hypotheses**

A review of the research questions and hypotheses for this study are shown below:

Question 1: What are elementary teachers’ beliefs about student autonomy and learning within a STEAM-focused environment?

Question 2: Is there a relationship between teachers’ beliefs about autonomy and their reported classroom practice?

Question 3: Are students’ perceptions of autonomy related to teachers’ actual classroom practices and beliefs?
Question 4: Does student perception of autonomy, student attitudes about STEM, and teaching style influence student engagement within a STEAM environment?

Hypotheses

1. Student perception of autonomy is related to student engagement. Student attitudes toward STEAM are related to student engagement, after controlling for student perceptions of autonomy, within a STEAM environment.

2. Teaching style moderates the student perception-student attitudes relationship to student engagement.

Because question four focused on predictors of student engagement in a STEAM environment, I employed HLM to account for the nested structure of the data that was collected. Based on the literature, students within a particular classroom should have similar experiences of autonomy based on their experiences within that setting. In the first model, predictor variables included student perceptions of autonomy and student attitudes toward STEM. The equations are shown below:

MODEL 1

Level-one model:

\[ Y_{ij}(\text{STUDENTENGAGEMENT}) = \beta_{0j} + \beta_{ij}\text{PERCAUTONOMY} + \beta_{2j}\text{STEAMATTITUDES} + r_{ij} \]

Level-two model:

\[ \beta_{0j} = \gamma_{00} + \gamma_{01}\text{HOMEROOM} + \mu_{0j} \]
\[ \beta_{ij} = \gamma_{10} + \gamma_{11}\text{HOMEROOM} + \mu_{1j} \]
\[ \beta_{2j} = \gamma_{20} + \gamma_{21}\text{HOMEROOM} + \mu_{2j} \]

Full model:

\[ Y_{ij}(\text{STUDENTENGAGEMENT}) = \gamma_{00} + \gamma_{01}\text{HOMEROOM} + \gamma_{10}\text{PERCAUTONOMY} + \gamma_{11}\text{PERCAUTONOMY*HOMEROOM} + \]
\[ \gamma_0 + \gamma_1 \text{HOMEROOM} + \mu_{ij} + \mu_j + r_{ij} \]

The second model, added a third predictor variable to the original model, teacher’s autonomous practices. The equations for this second model are shown below:

**MODEL 2**

Level-one model:

\[ Y_{ij}(\text{STUDENTENGAGEMENT}) = \beta_0 + \beta_1 \text{PERCAUTONOMY} + \beta_2 \text{STEAMATTITUDES} + \beta_3 \text{AUTONOMYPRAC}\]

Level-two model:

\[ \beta_0 = \gamma_{00} + \gamma_{01} \text{HOMEROOM} + \mu_{0j} \]
\[ \beta_1 = \gamma_{10} + \gamma_{11} \text{HOMEROOM} + \mu_{1j} \]
\[ \beta_2 = \gamma_{20} + \gamma_{21} \text{HOMEROOM} + \mu_{2j} \]
\[ \beta_3 = \gamma_{30} + \gamma_{31} \text{HOMEROOM} + \mu_{3j} \]

Full Model:

\[ Y_{ij}(\text{STUDENTENGAGEMENT}) = \gamma_{00} + \gamma_{01} \text{HOMEROOM} + \gamma_{10} \text{PERCAUTONOMY} + \gamma_{11} \text{PERCAUTONOMY} \times \text{HOMEROOM} + \gamma_{20} \text{STEAMATTITUDES} + \gamma_{21} \text{STEAMATTITUDES} \times \text{HOMEROOM} + \gamma_{30} \text{AUTONOMYPRAC} + \gamma_{31} \text{AUTONOMYPRAC} \times \text{HOMEROOM} + \mu_{0j} + \mu_{ij} + \mu_{2j} + \mu_{3j} + r_{ij} \]
CHAPTER FOUR

RESULTS

The findings reported in this chapter are based on the questions shared in the previous chapter and the analysis of the following data sources: semi-structured interviews, teacher and student participant surveys, and classroom observations. Both qualitative and quantitative analyses are discussed. Each research question is addressed in order.

Beliefs about Autonomy and Learning

This section describes the types of themes that emerged from teacher semi-structured interviews. Teachers responded to interview questions at differing degrees. Some participants talked at length on the various questions; other participants made fairly equal contributions across all questions. Pseudonyms will be used when using examples from teacher responses.

The following themes emerged from the data:

1. The definition of autonomy and its importance for students

2. How learning occurs

3. Metaphors for traditional teaching vs. STEAM teaching

While each theme is discussed as being discrete, overlap does occur among them. In addition, participants’ responses to interview questions frequently included more than one theme. In those instances, the interview data are described where they appeared to make the most logical sense. Each theme is discussed in terms of data collection and data analysis.

Theme 1: The definition of autonomy and its importance for students

Each part of theme 1 is divided into sections based on participants’ understanding of
autonomy and their reported classroom practices related to autonomy.

**Data collection.** When asked to define autonomy, teachers basically fell into three groups: autonomy as freedom or choice, autonomy as ownership of learning or they were unclear about autonomy. In general, most teachers described autonomy as some sense of freedom to choose, self-direction or taking charge of their own learning.

One teacher, Helen, summed it up best by describing autonomy as the freedom to choose or self-direct, not like a free for all, but as “knowing my goal and that I can kind of map out how I get there. As a teacher, it is important to help students build the skills to know how to navigate in that freedom of making choices.”

Another teacher, Celeste, described it as being “independent with your learning” or “taking the skills and tools they’ve learned and initiating or tackling more complex tasks independent of teacher direction.” This again points back to self-directed learning.

Mrs. Phillips also described autonomy as students feeling a sense of ownership in their own classroom. “You want the kids to be like ‘this is my classroom. I make decisions in here and I’m a part of it. My teacher’s not just going to decide on something. She is going to see how I feel about it.’”

When asked to discuss the importance of autonomy for students and their learning, all teachers recognized the importance of autonomy. Several teachers gave specific examples of how they attempt to support autonomy in their classrooms on a regular basis. These included the following: developing the class ‘flight plan’ together (an example of organizational autonomy- support); making connections to real-world or relatable scenarios (cognitive autonomy support) acknowledging students’ feelings; letting students choose their own topics for research projects or their own presentation materials to demonstrate their learning.
A few teachers expressed that while they believe student autonomy is important, that it can be difficult to support. Reasons given for this struggle included: lack of independence in students, students’ lack of intrinsic motivation, uncertainty about how to support student autonomy and teacher’s own lack of autonomy.

Three of the teachers were unclear of the meaning of autonomy and when asked if they could describe or define autonomy responded with “no,” “not really,” and “everybody working towards the same goal for the greater good, is that right?” When given some guidance and asked to discuss autonomy’s importance, the former stated that a sense of autonomy “helped students to be more willing to learn especially if they feel they have a sense of what they believe they can control. Then they’re more engaged.” The latter acknowledged that a sense of autonomy is important but also shared that it is a struggle to know how to best support student autonomy particularly when students don’t seem to be “intrinsically motivated to learn.” These definitions of autonomy align with current understanding of self-determination theory as described and studied in the literature (Deci, Sewart, Sheinman & Ryan, 1981; Reeve & Halusic, 2009).

**Theme 2: How learning occurs**

Teachers were asked how they knew learning was occurring in their classrooms and how their students learn math and science the best. All eight teachers reported that their students learned math and science best through hands-on experiences with the use of manipulatives and numerous opportunities for practices. A couple of teachers added that collaborative or cooperative peer activities also supported student learning. When asked how they knew learning was occurring among their students all eight teachers described the “chatter” they hear in their classrooms. This involved peer to peer chatter as well as informal
conversations students had with teachers about things they had applied at home or noticed in their neighborhood. Helen described this as students taking ownership for their learning.

“When my students take ownership of their learning and they can describe a concept in their own words or they can make a connection to it, like ‘teacher, I saw a truss bridge last night, or I saw a pillar bridge down there by the train tracks.’ Then I know they understand the different types of bridges we have learned about.”

Helen, along with several other teachers, also mentioned the importance of both formative and summative assessments. Gail specifically expressed the importance of the constructed responses which are a part of both formative and summative assessments for students.

“When children are writing their answers, they have to explain how they got their answer. It helps the children to analyze what they think they know with that they really know and it also helps the teacher get an understanding of where the gaps are in their learning. When I see that, then I know they’ve got it to this point but this is where they fall off.”

When examining teacher’s definitions of autonomy and their discussion about learning, they appeared to align. For example, teachers who defined autonomy as choice or ownership of learning, were more explicit in their description of learning and emphasized strategies that would be considered autonomy-supportive in the context of the literature. This would indicate that those who have an explicit understanding of autonomy are better able to identify and describe autonomy-supportive practices that they are aware of and utilize.
Theme 3: Metaphor Analysis: Traditional teaching vs. STEAM teaching

Finally, teachers were asked to think of two metaphors: one for teaching in general and another for teaching STEAM or in a STEAM context. In order to analyze the teacher metaphors by type, I began with the metaphor categories developed by Cassel and Vincent (2011) and added one additional category. Table 4.1 provides the names of the categories, frequencies and percentages for each in either traditional or STEAM teaching. Definitions and examples of each metaphor are found after the table. A chi-square test was also performed and no relationship was found between the categorical classification of metaphors based on the type of teaching described, $\chi^2 (5, N=8) = 8.67 p = .12$.

Table 4.1
Traditional and STEAM Teaching Metaphor Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency—Traditional Teaching (%)</th>
<th>Frequency—STEAM teaching (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-product</td>
<td>2 (25%)</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>End-product/process</td>
<td>0</td>
<td>4 (50)</td>
</tr>
<tr>
<td>Process</td>
<td>1 (12.5%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Overwhelming/Restrictive</td>
<td>3 (37.5%)</td>
<td>0</td>
</tr>
<tr>
<td>Unclear</td>
<td>1 (12.5%)</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>Philosophical</td>
<td>1 (12.5%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Category 1: End-Product

Participant responses which included words or phrases such as outcomes, laying a foundation, and developing skills were placed in the “end-product” category. Two traditional teaching metaphors and 1 STEAM teaching metaphor fell into this category.
Sample End-Product Metaphors

1. “Teaching is like a pastor or minister nurturing his flock. He is making sure they are giving them the information that they need to be better in life. To make sure they have a productive life. To make sure that they are successful in life and giving them the tools they need. In teaching, giving them the strategies, giving them some of the knowledge so they can be successful.”

2. “Teaching is like an orchestra full of instruments that all have different tunes. I am the conductor and my students are the instruments. It’s my job to take all these different instruments and make beautiful music.”

3. Teaching STEAM is like a puzzle because of all of the elements of STEAM. They work together to make a beautiful puzzle.

These metaphors focus on the end—the puzzle, the music, and a successful life. These tend to focus on the teacher as the authority on knowledge who actively pass knowledge on to the students who are more passive receivers.

Category 2: End-product/process

Participant responses that included words or phrases such as don’t always go as planned, endless possibilities, or outcome could change. Each of these metaphors implies that outcomes can shift or change during the process of learning.

Sample End-Product/Process Metaphors

1. “Teaching STEAM is like going to the Olympics. It’s a wonderful opportunity. Design challenges in my classroom is that they don’t always go the way we planned for them too, but it was just cool to show up and do something awesome that day. I think that’s how Olympians feel.”
2. “Teaching STEAM is like a choose your own adventure story because it has endless possibilities and what you thought might be the outcome could change by the time you get to the end.”

3. “Teaching STEAM is like driving a car. You can go fast at times, you can go slow but you always get someplace and you always get where you need to go.”

4. “Teaching STEAM is like a kaleidoscope or prism. STEAM lets children know there are many aspects to learning and you can be great in any of those. It’s like everyone has an opportunity to be an intricate part of the learning process. Nobody is left out because it takes all of these components to make it work.”

With these metaphors, teachers adjust their actions based on the choices the learners make. As seen in the descriptions, all of the end-product/process metaphors came from descriptions of STEAM teaching.

Category 3: Process Metaphors

Process metaphors emphasize words or phrases such as change, growth, never knowing what will happen.

Sample Process Metaphors

1. “Teaching is like a flower because they’re always growing and you get to see them blooming, always blooming. I am the Gardener and I’m growing tomorrow’s leaders.”

2. “Teaching STEAM is like handling explosives because you never know what’s going to happen. And I try to tell my students, ‘If you don’t make any mistakes, then you didn’t do anything, because do you think the first light bulb was made on the first try? It was not. Do you think the first Picasso painting was worth a million dollars? It was not.
And I tell them it’s ok to mess up. I love for them I really do, when we’re doing science to mess up, so they can go back and think and revamp. Those ‘explosions’ are opportunities for them to think and learn.”

3. “Teaching STEAM is like being at the fair but you don’t need money. You can just ride every ride you want. Nobody’s charging you. You can go and get funnel cakes and cotton candy and you can play games over and over again and everybody gets a turn. At school that means you can mess up and it’s ok. You can play again until you figure it out or change things up just because.”

Category 4: Overwhelming Metaphors

Metaphors which fell into category 4 included descriptive words such as constricted, demanding, and so much going on. These metaphors also tended to focus more on the negative aspects of instruction.

Sample Overwhelming Metaphors

1. “Teaching is like a boa constrictor. It is constrictive because we are not allowed to do as much because of demands and how we have to stick to curriculum and you cannot go off the wall away—not off the wall but away from where they want us to teach it. For example, with reading, you’re restricted to—you have to teach specific skills within that week. The same with math. I mean everything is mandated to the test. It’s always one speed and that’s not fair to these kids.”

2. “Teaching is like juggling several balls. The balls are like the children in your classroom. You have to keep them all up in the air but if you mess up one, then a ball drops or a child fails and you never want that.”

3. “Teaching is like juggling because there’s so many things going on and I don’t want
to drop anything or it’s like juggling because I want to keep all of my students up.
Up, up, up and don’t want to let any of them fall, especially not without me noticing that one of them fell.”

Category 5: Unclear Metaphors

Unclear metaphors did not easily fit into any of the other categories. They did not describe an end-product or a process.

1. “Teaching STEAM is like a rollercoaster because sometimes it’s really scary when you’re climbing, but then sometimes it’s really fun, and you just get to put your hands in the air and say “Woohoo!”
2. “Teaching is like a box of chocolates because you never know what you’re going to get, every day, every minute, every hour.”

Category 6: Philosophical Metaphor

One philosophical metaphor was generated during the interviews. This metaphor was more about internal beliefs of the teacher or the heart of the teacher and did not really address process, end-product or interaction.

Sample Philosophical Metaphor

1. “Teaching is like a calling because not just anyone can do it. It’s a calling, not a career. It’s not a job just for anybody. It is something that has to be inside of you before anybody ever gives you the content or makes you read a book or makes you do any kind of internship. It’s something that you should already know if you’ve got it before you ever walk into a college campus.”

General observations showed that teachers seemed more animated when talking about STEAM teaching and had a more positive outlook overall about STEAM teaching.
Metaphors referenced excitement, high energy, process-orientation and enjoyment. When examining the relationships across the three identified themes, additional patterns were found. Teachers with a clear definition of autonomy were able to talk about learning in a way that recognized and supported student autonomy. Their traditional metaphors about teaching also tended to be richer. For the majority of teachers, their STEAM metaphors were more autonomy-focused in nature as they emphasized process orientation. For those teachers who were unclear about the meaning of autonomy, their metaphors were also unclear or focused on feeling overwhelmed/restricted during teaching. This could mean that on some level, teacher understanding of, or beliefs about autonomy has some degree of impact on their classroom practice.

**Relationships between Teacher Beliefs and Actual Classroom Practice**

Quantitative findings began with a correlational analysis of the relationships between teacher beliefs and their actual classroom practice. Various autonomous practices were observed and coded using the Teaching Dimensions Observation Protocol during classroom observations. Those practices included the following observed behaviors: making connections to learning, problem-solving activities, creating, providing multiple examples, emphasizing relevance of content, acknowledging student interest and student choice. A definition of each of these can be found in table 4.2 which also shows the average number of times each practice was observed across teachers and the overall observed percentage of each practice across observation intervals. It is important to note that anytime a practice was observed during the 2-minute intervals that it was recorded. This allowed for multiple practices to be recorded within the same interval. Some autonomous practices were observed at a much greater frequency than others. This was more than likely due to the fact that certain content areas, particularly math and science tended to lend
Table 4.2

<table>
<thead>
<tr>
<th>Observed practice</th>
<th>Definition</th>
<th>Avg. across teachers</th>
<th>Percentage observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection to Learning (CNL)</td>
<td>Students are given examples that clearly and explicitly link course material to popular culture, the news, and other common student experiences.</td>
<td>3.6</td>
<td>5</td>
</tr>
<tr>
<td>Problem-Solving Activities (PS)</td>
<td>Students are asked to actively solve a problem. This is evident through explicit verbal or written requests to solve a problem.</td>
<td>36.9</td>
<td>49</td>
</tr>
<tr>
<td>Creating Activities (CR)</td>
<td>Students are provided with tasks or dilemmas were the outcome is open-ended rather than fixed. Can be verbal or written. Can be co-coded with PS</td>
<td>18.86</td>
<td>25</td>
</tr>
<tr>
<td>Providing multiple examples (ANEX)</td>
<td>The instructor gives examples or solutions to course content or asks students to identify multiple examples or solutions. Can be co-coded with PS</td>
<td>13.86</td>
<td>18</td>
</tr>
<tr>
<td>Emphasizing relevance of content (EMP)</td>
<td>The instructor clearly states that something is important for students to learn for their future careers, future or more advanced coursework, future life</td>
<td>8.57</td>
<td>11</td>
</tr>
<tr>
<td>Acknowledging student interest (SINT)</td>
<td>The instructor gives students the opportunity to complete a project or activity based on their personal interest or student-driven inquiry. Frequently co-coded with CH</td>
<td>9.71</td>
<td>13</td>
</tr>
<tr>
<td>Student Choice (CH)</td>
<td>The instructor offers students choices about their small group members, their instructional materials and provides students opportunities to demonstrate their understanding in their own way. Frequently co-coded with SINT</td>
<td>5.29</td>
<td>7</td>
</tr>
</tbody>
</table>

themselves to specific practices (i.e. problem-solving and creating).

Three measures were used to examine teachers’ reported autonomy. These particular measures were chosen because they have been found to correlate well in previous studies of autonomy support. However, when running correlations of these three measures, in this
particular study, correlations were extremely limited. In fact, table 4.3 shows only 4 significant correlations and only one of those is between autonomy-support measures. The instructional management subscale of the Behavior and Instructional Management Scale had a moderately significant positive correlation with the relevance subscale of the Teacher as Social Context Scale. This relationship corresponds with existing literature in the sense that teachers who emphasize relevance use this strategy to support students content connections to the real world during academic instruction.

Table 4.3
\textit{Relationships between Teacher Measures of Autonomy}

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<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High autonomy</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. High control</td>
<td>.273</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>3. Moderate control</td>
<td>-.177</td>
<td>.825*</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. Moderate autonomy</td>
<td>.451</td>
<td>.695</td>
<td>.601</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. Behavior management</td>
<td>-.165</td>
<td>.336</td>
<td>.479</td>
<td>.267</td>
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<td></td>
<td></td>
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<tr>
<td>6. Instructional management</td>
<td>-.557</td>
<td>-.235</td>
<td>-.113</td>
<td>-.344</td>
<td>-.383</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>7. Choice</td>
<td>-.272</td>
<td>-.198</td>
<td>.160</td>
<td>-.269</td>
<td>-.086</td>
<td>.141</td>
<td>1</td>
<td></td>
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<tr>
<td>8. Control</td>
<td>.507</td>
<td>.356</td>
<td>.147</td>
<td>.505</td>
<td>.692</td>
<td>-.458</td>
<td>-.339</td>
<td>1</td>
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<tr>
<td>9. Respect</td>
<td>.174</td>
<td>.433</td>
<td>.280</td>
<td>.417</td>
<td>-.494</td>
<td>.124</td>
<td>-.070</td>
<td>-.369</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10. Relevance</td>
<td>-.111</td>
<td>.165</td>
<td>.018</td>
<td>.071</td>
<td>-.608</td>
<td>.765*</td>
<td>-.196</td>
<td>-.417</td>
<td>.628</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11. Total autonomy</td>
<td>.325</td>
<td>.274</td>
<td>.286</td>
<td>.371</td>
<td>.194</td>
<td>-.791*</td>
<td>.160</td>
<td>.100</td>
<td>.336</td>
<td>-.521</td>
<td>1</td>
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*Correlation is significant at the 0.05 level (2-tailed).

Table 4.4 shows the relationship between the Problems in School Questionnaire (PIS) and teacher’s observed classroom practices. Subscales in the PIS are high autonomy, high control, moderate autonomy and moderate control or items 1-4 in table 4.4. Scores for this measure range from high autonomy to high control. When examining the mean scores for each subscale on the PIS, high autonomy and moderate control subscales had the highest means, followed by moderate autonomy with high control having the lowest mean. Typically, when teachers score higher on autonomy subscales,
they are lower on control subscales. These findings are similar to other samples found in the literature. While teachers recognized the need for autonomy and seemed to value autonomy, they also recognized the need for some degree of control. This is similar to other studies which recognize the importance of both autonomy and structure for students. The remaining items in the table are the observed practices taken from the TDOP. There was a moderate, positive correlation between the high control and moderate control subscales of the PIS. This correlation was to be expected as they are similar subscales within the same instrument. There was also a moderate, positive correlation between the PIS subscale of moderate control and the observed practice of connection to learning.

There were no significant relationships between the high autonomy subscale and observed autonomous practices nor were relationships found between the high control subscale and any observed autonomous practices. As suspected, there appeared to be a discrepancy between the teachers’ reported autonomous beliefs and observed autonomous practices. While one would hope there was some relationship between beliefs and practices, teacher beliefs may not necessarily play out the same way in practice. Also of note in this correlation was a moderate, negative relationship between the moderate autonomy subscale and observed problem-solving activities. Teachers with moderate control scores were more likely to make content connections to other areas of learning and experiences. Teachers with moderate autonomy scores were less likely to use problem-solving activities in their classroom. This could mean that teachers felt that problem-solving activities required a different level of structure or that their students needed more supports during problem-solving activities than others. Both of these relationships must be interpreted loosely as they are a comparison of only
8 classrooms within the same school environment and this could have some impact on variability.

Table 4.4  
Relationship between Reported Autonomy and Observed Autonomous Practices

<table>
<thead>
<tr>
<th></th>
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<th>2</th>
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<tbody>
<tr>
<td>1. High Autonomy</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Connect to Learning</td>
<td>-.234</td>
<td>.687</td>
<td>.715*</td>
<td>.346</td>
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<tr>
<td>6. Problem-Solving</td>
<td>-.287</td>
<td>-.358</td>
<td>-.297</td>
<td>-.798*</td>
<td>-.244</td>
<td>1</td>
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<td></td>
</tr>
<tr>
<td>7. Creating</td>
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<td>-.098</td>
<td>.003</td>
<td>-.088</td>
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<td>-.333</td>
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<tr>
<td>8. Emphasis</td>
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<td>.542</td>
<td>.533</td>
<td>.064</td>
<td>.816*</td>
<td>-.117</td>
<td>.436</td>
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<tr>
<td>9. Another Example</td>
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<td>.234</td>
<td>.332</td>
<td>-.314</td>
<td>.333</td>
<td>.697</td>
<td>-.105</td>
<td>.225</td>
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<tr>
<td>10. Student Interest</td>
<td>-.011</td>
<td>.052</td>
<td>-.080</td>
<td>-.554</td>
<td>.056</td>
<td>.551</td>
<td>.254</td>
<td>.230</td>
<td>.619</td>
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</tr>
</tbody>
</table>

N     8    8    8    8    8    8    8    8    8    8    8
M     6.25 | 3.81 | 5.58 | 4.70 | 3.13 | 32.25 | 16.5 | 7.5  | 12.1 | 8.5  | 4.63 |
SD    .69  | 1.35 | .84  | .97  | 4.32 | 20.89 | 9.13 | 7.35 | 9.13 | 9.12 | 5.18 |

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

Table 4.5 looks at the relationship between another measure of autonomy, the Teacher as Social Context (TASC) and observed autonomous practices. The TASC contains subscales for choice, control, respect and relevance as displayed in items 1-4 in the table. Mean scores on the TASC autonomy scores were somewhat lower than the autonomy scores found with the PIS. However, relevance, a salient feature of autonomy practice had the highest mean. This subscale has been found to be of particular importance in the literature and this finding confirms that as well. Relevance is one of the most significant ways that teachers are able to help students make connections between academic content and the real world or future application. Again, the observed autonomous practices were connection to learning, problem-solving activities, creating, emphasis, another example, student interest and student choice. As expected, there was a
moderate correlation between the respect and relevance subscale items within the TASC.

A review of the literature shows that these two items are frequently found together when examining autonomy support. There was also a moderate positive correlation between the TASC’s choice subscale and providing exemplars. Teachers who scored high on the choice subscale were more likely to provide students with multiple examples during instruction and to allow students to choose to demonstrate their understanding in the way that was most meaningful to them. An additional moderate correlation was found between the autonomous practices of connection to learning and content emphasis. This appears to be a logical relationship as content emphasis and connection to learning both support students in understanding how content is related to their experiences, in the past and the potential for future use.

**Table 4.5**

*Relationship between Teacher as Social Context Scale (TASC) and Autonomous Practices*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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</thead>
<tbody>
<tr>
<td>1. Choice</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>2. Control</td>
<td>-.366</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>3. Respect</td>
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<td>.100</td>
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<tr>
<td>4. Relevance</td>
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<tr>
<td>5. Connect to Learning</td>
<td>.316</td>
<td>-.076</td>
<td>-.125</td>
<td>.363</td>
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<td></td>
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</tr>
<tr>
<td>6. Problem-Solving</td>
<td>.195</td>
<td>-.085</td>
<td>-.435</td>
<td>-.664</td>
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<td>7. Creating</td>
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<td>.444</td>
<td>.276</td>
<td>.241</td>
<td>-.333</td>
<td>1</td>
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</tr>
<tr>
<td>8. Emphasis</td>
<td>.288</td>
<td>-.142</td>
<td>.179</td>
<td>.303</td>
<td>.816*</td>
<td>-.117</td>
<td>.436</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>9. Another Example</td>
<td>.711*</td>
<td>-.102</td>
<td>-.255</td>
<td>-.111</td>
<td>.333</td>
<td>.697</td>
<td>-.105</td>
<td>.225</td>
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<tr>
<td>10. Student Interest</td>
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<td>-.528</td>
<td>-.029</td>
<td>-.148</td>
<td>.056</td>
<td>.551</td>
<td>.254</td>
<td>.230</td>
<td>.619</td>
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<td></td>
</tr>
</tbody>
</table>

*N* 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8

*M* 2.84 2.24 2.78 3.06 3.13 32.25 16.5 7.5 12.13 8.5 4.63

*SD* .60 .36 .34 .61 4.32 20.89 9.13 7.34 9.13 9.11 5.18

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

While there appeared to be a few moderate correlations, there were minimal
correlations between teachers’ reported practices and their observed practices. In fact, no relationship was found between relevance and any of the observed practices related to relevance. This could indicate that there is a gap between what teachers report about autonomy and how it actually plays out in their classroom practice.

Table 4.6 explored the relationship between the Behavioral and Instructional Management Scale (BIMS) and observed teacher practices. The BIMS contained two subscales: behavioral management and instructional management. Mean scores on the BIMS appeared to emphasize management of behavior in the classroom, which is typically perceived as control or structure.

Table 4.6

<table>
<thead>
<tr>
<th>Behavior/Instruction Management and Autonomous Practice</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>9</th>
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<tbody>
<tr>
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<td>2.Instruction management</td>
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<tr>
<td>3.Connect to Learning</td>
<td>.201</td>
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<tr>
<td>4.Problem-Solving</td>
<td>.074</td>
<td>.276</td>
<td>-.244</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.Creating</td>
<td>-.408</td>
<td>-.329</td>
<td>.241</td>
<td>-.333</td>
<td>1</td>
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<td></td>
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</tr>
<tr>
<td>6.Emphasis</td>
<td>.292</td>
<td>-.209</td>
<td>.816*</td>
<td>-.117</td>
<td>.436</td>
<td>1</td>
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<tr>
<td>7.Another Example</td>
<td>.106</td>
<td>.138</td>
<td>.333</td>
<td>.697</td>
<td>-.105</td>
<td>.225</td>
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<td></td>
</tr>
<tr>
<td>8.Student Interest</td>
<td>-.462</td>
<td>.155</td>
<td>.056</td>
<td>.551</td>
<td>.254</td>
<td>.230</td>
<td>.619</td>
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<td></td>
</tr>
</tbody>
</table>

N 8 8 8 8 8 8 8 8 8
M 4.64 2.10 3.13 32.25 16.50 7.5 12.13 8.50 4.63
SD .55 .47 .432 20.89 9.13 7.35 9.13 9.12 5.18

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

Previous studies have demonstrated a significant correlation between the BIMS and the PIS, a previously discussed measure of reported autonomy, and this was an attempt to validate that relationship by using it as another measure of autonomy. In this instance, it does not appear to correlate with observed autonomous practices in this small group of
teachers. A positive significant correlation was found between the autonomous practices of making connections to learning and content emphasis. For students, this meant that teachers who made real-world connections to learning were also likely to emphasize how academic content related to student experiences and future career options.

**Relationships Between Student Perceptions of Autonomy and Teacher Practices**

After exploring relationships between teacher data, I examined the relationships between students’ perceptions of autonomy and teacher’s autonomous beliefs and practices. One hundred twenty students in third through fifth grades were surveyed. Thirty-three percent of students were in 3rd grade classrooms. Thirty-seven percent of students were in 4th and thirty percent of students were in 5th grade. Fifty-three percent of students were male and forty-seven percent were female.

Table 4.7 displays students’ perceived autonomy (item 1), teacher’s autonomy belief scores from the PIS (items 2 and 3), and observed classroom practices as coded from the TDOP (items 4-10). As seen in Table 4.7, there was a positive and significant relationship between students’ perception of autonomy and teacher’s use of examples. As teachers’ use of examples and opportunities for students to choose an exemplar to explain their understanding increased, student perception of autonomy also increased. There was no significant relationship found between student perceptions of autonomy and teachers’ autonomous belief scores. There was also a significant relationship between all of the autonomous practices defined in the study. Teachers who used one autonomous practice were more likely to use other autonomous practices in their classroom.
Impact of Student Perceptions on Engagement

The final question in this study examined the impact of student perceptions and attitudes on their level of engagement. First, all student-level variables were examined to look for correlations. Those correlations are reported in Table 4.8. Statistically significant relationships were found among all of the variables.

Table 4.7
_Perceived Autonomy and Teacher Autonomous Beliefs and Practices_

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
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<td>1. Perceived autonomy</td>
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<td></td>
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</tr>
<tr>
<td>2. Mod. Autonomy</td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>3. High autonomy</td>
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<tr>
<td>4. Connect 2 learning</td>
<td>.086</td>
<td>.603**</td>
<td>-.240**</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Examples</td>
<td>.259**</td>
<td>.351**</td>
<td>-.123</td>
<td>.166</td>
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</tr>
<tr>
<td>6. Problem-solving</td>
<td>.120</td>
<td>-.526**</td>
<td>-.260**</td>
<td>-.227*</td>
<td>.527**</td>
<td>1</td>
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</tr>
<tr>
<td>7. Creating</td>
<td>-.034</td>
<td>.537**</td>
<td>.188*</td>
<td>.215*</td>
<td>-.129</td>
<td>-.796**</td>
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</tr>
<tr>
<td>8. Student interest</td>
<td>.090</td>
<td>.001</td>
<td>-.064</td>
<td>.073</td>
<td>.639**</td>
<td>.501**</td>
<td>-.051</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Emphasis</td>
<td>.065</td>
<td>.609**</td>
<td>-.105</td>
<td>.773**</td>
<td>.158</td>
<td>-.413**</td>
<td>.679**</td>
<td>.169</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10. Student choice</td>
<td>.091</td>
<td>-.049</td>
<td>-.030</td>
<td>.287**</td>
<td>.465**</td>
<td>.259**</td>
<td>.262**</td>
<td>.710**</td>
<td>.504**</td>
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</tr>
</tbody>
</table>

N: 120 120 120 120 120 120 120 120 120 120
SD: .54  .80  .63  4.76  8.82 18.50 8.83 7.74 7.52 4.36

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

Table 4.8
_Correlations among student-level variables_

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived autonomy</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. STEAM attitudes</td>
<td>.214*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3. ENGAGE total</td>
<td>.449**</td>
<td>.374**</td>
<td>1</td>
</tr>
</tbody>
</table>

N: 120 120 120
M: 3.60 3.54 3.77
SD: .54  .51  .71

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
HLM was used to test the main hypothesis: that teacher practices are a predictor for student engagement when controlling for student attitudes toward STEM and student perceptions of autonomy. Again, HLM was selected due to the nested nature of the data. I began with multi-level tests to estimate the extent to which perception of autonomy and STEAM attitudes were predictive of student engagement. The initial findings can be found in table 4.9. When examining the effects of perceived autonomy and STEAM attitudes on student engagement at the student level, there appeared to be no initial impact. However, the purpose of this investigation was to investigate the experiences of students within their classrooms. It is because we know that students in school function within smaller classroom environments, that the next step was to look at classroom level effects on student engagement.

Table 4.9
Student Level Effects on Student Engagement

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower bound</td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.781468</td>
<td>2.181726</td>
<td>.416</td>
<td>-6.102651</td>
</tr>
<tr>
<td>Perceived autonomy</td>
<td>1.153943</td>
<td>.615881</td>
<td>.063</td>
<td>-.065886</td>
</tr>
<tr>
<td>STEAM attitudes</td>
<td>1.073110</td>
<td>.634560</td>
<td>.094</td>
<td>-.183716</td>
</tr>
<tr>
<td>Perceived autonomy*STEAM</td>
<td>-.187973</td>
<td>.177258</td>
<td>.291</td>
<td>-.539055</td>
</tr>
<tr>
<td>attitudes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Engagement

To explore the variables of perceived autonomy and attitudes toward STEAM within classrooms, HOMEROOM was added in level 2 of the model discussed in chapter 3. Several things were observed. In table 4.10, perceived autonomy ($b=-2.392, p > .05$) does not have a significant impact on student engagement nor does attitudes towards STEAM
However, the coefficient relating to homeroom was negative and statistically significant \( b=-2.123, p<.05 \). This means that between homerooms, student’s level of engagement was negatively impacted by their participation in certain classrooms. The interaction between perceived autonomy and attitudes towards STEAM was not statistically significant \( b=.922, p>.05 \); which means that student’s perception of autonomy had no effect on their attitudes towards STEAM. However, homeroom was found to be negative and significant \( b=-2.123, p<.05 \). Student’s perception of autonomy by homeroom was found to be positive and significant \( b=.590, p<.05 \), which means that student’s level of engagement within individual homerooms was impacted by their perception of autonomy within those classrooms. In addition, attitudes toward STEAM by homeroom were also found to be positive and significant \( b=.680, p<.05 \). The cross-level interaction between student’s perceived autonomy, attitudes toward STEAM and their homeroom was negative and significant \( b=-.190, p<.05 \). This means that, within homerooms, participation in those rooms had a small but negative impact on students’ perceptions of autonomy and their attitudes towards STEAM. This confirmed the hypothesis that student perceptions of autonomy and attitudes toward STEAM would be significant predictors of student engagement.

Table 4.10

\textit{Classroom and Student Level Effects on Student Engagement}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. error</th>
<th>t</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>10.822236</td>
<td>6.183051</td>
<td>1.750</td>
<td>.083</td>
</tr>
<tr>
<td>Perceived Autonomy</td>
<td>-2.392217</td>
<td>1.789074</td>
<td>-1.337</td>
<td>.184</td>
</tr>
<tr>
<td>STEAM Attitudes</td>
<td>-2.912033</td>
<td>1.845988</td>
<td>-1.577</td>
<td>.118</td>
</tr>
<tr>
<td>Perceived Autonomy *STEAM Attitudes</td>
<td>.922319</td>
<td>.531021</td>
<td>1.737</td>
<td>.085</td>
</tr>
<tr>
<td>HOMEROOM</td>
<td>-2.123214</td>
<td>.976294</td>
<td>-2.175</td>
<td>.032</td>
</tr>
<tr>
<td>PercAutonomy*HOMEROOM</td>
<td>.589980</td>
<td>.279579</td>
<td>2.110</td>
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</tr>
<tr>
<td>STEAMAtt*HOMEROOM</td>
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<td>.021</td>
</tr>
<tr>
<td>PercAutonomy<em>STEAMAtt</em>HOMEROOM</td>
<td>-.186907</td>
<td>.082635</td>
<td>-2.262</td>
<td>.026</td>
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</tbody>
</table>

a. Dependent Variable: Engagement
At this stage, the specific characteristics of each classroom that are impacting engagement are unknown. For the purposes of this study, the next step was to examine whether teacher’s autonomous practices were a factor impacting student engagement. This required the addition of a third and final variable to the model to examine the impact of teaching practices on student engagement. The original model demonstrated a significant difference between homerooms. In addition, the original hypothesis proposed that teacher’s autonomous practices would be a significant predictor of student engagement. Therefore, we would hope to find significance when adding teacher practices to the model. At the student level, none of the covariates were found to be significant predictors as seen in table 4.11. This is similar to the findings in the original model when looking across classroom. Because of the findings within homerooms in the first model, it was important to again examine the data at the classroom level for this second model.

As shown in Table 4.12, when examining the covariates at the classroom level, teacher’s autonomous practices are still not a significant predictor of student engagement. In fact, none of the covariates were found to be significant predictors in this model.

Table 4.11
Student level Effects with the Addition of Teacher Practice

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-1.134</td>
<td>.259</td>
</tr>
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<td>Perceived Autonomy</td>
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<td>2.069084</td>
<td>1.443</td>
<td>.152</td>
</tr>
<tr>
<td>STEAM Attitudes</td>
<td>2.718134</td>
<td>2.115424</td>
<td>1.285</td>
<td>.201</td>
</tr>
<tr>
<td>Teacher Practices</td>
<td>.487986</td>
<td>.493456</td>
<td>.989</td>
<td>.325</td>
</tr>
<tr>
<td>Perceived autonomy*Teacherprac</td>
<td>-.144331</td>
<td>.143143</td>
<td>-1.008</td>
<td>.315</td>
</tr>
<tr>
<td>STEAMatt*Teacherprac</td>
<td>-.126573</td>
<td>.146022</td>
<td>-.867</td>
<td>.388</td>
</tr>
<tr>
<td>PERCAUT<em>STEAMAtt</em>Teacherprac</td>
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<td>.041575</td>
<td>.892</td>
<td>.374</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Engagement

From this, we can determine that the first model was the best fitting model. This means that while there are classroom level effects on students’ perceptions of autonomy and their
attitudes towards STEAM, teacher’s autonomous practices did not influence those variables. This could mean that there are some other characteristics at the classroom level that are influencing student engagement. It could be that there are some other aspects of self-determination theory or other environmental factors that are more significant influences on students’ perceptions and their engagement within STEAM environments.

Table 4.12

*Student and Classroom Level Effects with Addition of Teacher Practice*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>.737</td>
<td>.463</td>
</tr>
<tr>
<td>Perceived Autonomy</td>
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<td>9.352011</td>
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<td>.490</td>
</tr>
<tr>
<td>STEAM Attitudes</td>
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<td>.368</td>
</tr>
<tr>
<td>Teacher Practices</td>
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<td>.718</td>
</tr>
<tr>
<td>PercAutonomy*Teacher practice</td>
<td>2.650717</td>
<td>2.745614</td>
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<td>.337</td>
</tr>
<tr>
<td>STEAM attitudes*Teacher practice</td>
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<td>.561</td>
<td>.576</td>
</tr>
<tr>
<td>PercAutonomy<em>STEAM Attitudes</em>Teacher practice</td>
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a. Dependent Variable: Engagement
CHAPTER 5
DISCUSSION AND CONCLUSION

This final chapter reviews the problem and methodology and then discusses the findings from Chapter four along with implication from these findings. There is a brief review of the research questions preceding the findings. Following the discussion of results, this chapter discusses the limitations of this study before discussing future directions of research.

Problem Statement

Teachers’ epistemological beliefs about learning and knowing influence their daily classroom practices, specifically in areas of language, math and science instruction (Dolphin & Tillotson, 2015; Hofer & Pintrich, 1997; Hofer, 2000; Oga-Baldwin & Nakata, 2015; Cotterall, 1995; Kuntze, 2012; Magno, 2011; Olafson & Schraw, 2006). This can have an impact on students’ engagement within those learning environments. Instructional environments that support student autonomy have been shown to support student engagement and enhance student achievement (Assor et al, 2002; Stephanou et al, 2004; Reeve et al, 2004). There is a limited amount of research on teacher practices related to autonomy support at the elementary level and its impact on student engagement.

This study added to the literature by exploring teacher beliefs and practices within a STEAM-focused environment at the elementary level. This study also examined students’ perceptions of autonomy and attitudes towards STEAM as a result of autonomy-supportive practices. Differences can be found with respect to the population being studied as this study focused primarily on African-American students.
Review of Methodology

This study used a mixed method design to collect both qualitative and quantitative information related to the questions stated above. A single data collection phase was used to collect qualitative and quantitative data simultaneously. This data included semi-structured interviews, metaphor analysis, surveys and direct classroom observations of third through fifth grade teachers, as well as survey data collected from third through fifth grade students. Participants were eight, third through fifth grade teachers with five being African-American and three being Caucasian. All teachers were female and had an average of 13.25 years of teaching experience. Half of the teachers had an advanced degree. One-hundred twenty student participants were included in this study fifty-three percent being male and forty-seven percent female, ninety percent were African-American, five percent Caucasian and five percent Hispanic. Grade distributions were fairly even with thirty-three percent of students in the third grade, thirty-seven percent in the fourth grade and 30 percent in the fifth grade.

Teacher measures included the Epistemological Beliefs Instrument (EBI; Chen & Elliott, 2002), the Problems in Schools Questionnaire (PIS; Deci et al., 1981), the Behavior and Instructional Management Scale (BIMS; Martin & Sass, 2010), the Teacher Efficacy and Attitudes Towards STEM (T-STEM; FIEI, 2012) and the Teacher as Social Context Questionnaire (TASC-Q; Belmont et al., 1988). Student survey measures included the Autonomy-Affecting Teacher Behavior Scale (Assor et al, 2002), Teacher as Social Context-Student (TASC-Student; Belmont et al, 1992), Motivation and Disaffection Scale-modified (Skinner et al, 2009) and Student Attitudes Toward STEM Survey (S-STEM; FIEI, 2012). Direct observations were conducted using the Teaching Dimensions Observation Protocol (TDOP; Hora & Ferrare, 2014). Its primary purpose is to examine the dynamic interactions that occur
between students and teachers during classroom instruction. For the purposes of this study, the focus was on teacher behaviors during instruction. This was a novel use of this protocol as it has only been used in post-secondary environments to evaluate STEM instruction.

Summary of Analysis

Grounded theory and metaphor analysis were used to explore themes in transcripts from teacher interviews. Patterns discussed with teachers included how learning occurs, autonomy and its importance and traditional teaching vs. STEAM teaching. Descriptive analyses were run using SPSS Statistics version 24 (IBM, 2016) to find demographic frequencies, means, standard deviations, and Pearson correlation coefficients and to construct hierarchical linear models. Many of the correlations found in the current data set confirmed other findings in the research literature with a few exceptions which will be discussed below. The hierarchical model generated from this analysis confirmed that student perception of autonomy and attitudes toward STEAM significantly predicted student engagement. However, teacher practices did not significantly predict student engagement which does not confirm research literature.

Discussion

This research study sought to address the following questions: 1) What are elementary teachers’ beliefs about student autonomy and learning within a STEAM-focused environment? 2) Is there a relationship between teachers’ beliefs about autonomy and their actual classroom practices? 3) Are students’ perceptions of autonomy consistent with teachers’ reported autonomy and their classroom practices? and 4) Does student perception of autonomy, student attitudes toward STEM, and teaching style influence student engagement within a STEAM environment?
Beliefs about Autonomy and Learning

The results from question 1 gave a qualitative picture of what teachers reported about student autonomy and learning from both their interviews and survey results. While most teachers seemed to have a general understanding of autonomy and its importance for students, their feelings about their ability to support student autonomy was less clear. A few teachers expressed frustration on how to best support students, emphasizing that their students were not intrinsically motivated which made it hard to give them autonomy in the classroom. While intrinsic motivation can be an issue with autonomy, it is also possible that teachers who reported difficulty supporting autonomy also did not have a clear understanding of what autonomy is which would make it more difficult to identify ways to support it.

From their discussion of learning and how it occurs, teachers emphasized the importance of hands-on and collaborative experiences. All teachers described the “chatter” that they hear among their students when they are engaged in learning and viewed this peer talk as important to the learning process. This chatter also included informal interactions between students and teachers and seemed to create a sense of community in the classroom. While not necessarily recognized by teachers, this acknowledgment of student voice and recognition of student connections to learning was one of the ways that teachers supported students’ autonomy and created a positive classroom climate. While teachers described this as students taking ownership for their learning, it was the teachers who created an environment that allowed students to take ownership. For some teachers, this was described as the general atmosphere of their classroom. For others, they discussed autonomy-support in relationship to specific activities or content areas.
Most teachers also recognized the importance of both formative and summative assessment as a means for demonstrating learning occurrences. While there was some frustration with the amount of assessment that was mandated by the school district, teachers did recognize the importance of multiple and varied assessments. Data from assessments was frequently used to make adjustments to instruction. The integration of constructed responses into current assessments appeared to help teachers not only understand what students had learned but to better identify gaps in student learning and their ability to articulate their understanding. This also aids teachers in adjusting their instruction. Overall, teachers reported that assessment was necessary but were divided on the amount and frequency of assessment that was needed.

Question 1 also allowed for the exploration and analysis of metaphors generated by teachers to describe teaching in general and STEAM-focused teaching. All teachers were able to generate responses for each metaphor with some being richer in detail than others. Six metaphor categories were used to classify the responses. Traditional teaching metaphors were more negative in tone for a larger number of teachers. This means they found traditional teaching to be more overwhelming or restrictive in nature. This sense could be attributed to district and curricular constraints, classroom behavioral issues or level of administrative support. This aligns with other findings in the literature around teacher pressures (Pelletier et al, 2002). STEAM teaching metaphors were more positive and more student-focused in nature. When talking about STEAM teachers were observed to be more animated and energized. They seemed to express more enjoyment and excitement about STEAM teaching and the opportunities it provided for both students and teachers.
Relationships between Reported Autonomous Practices and Actual Practice

Moving into the quantitative portion of the data, question 2 explored the relationships between teacher’s reported beliefs about autonomy and practices and their actual classroom practice. This correlational analysis found limited correlations between reported autonomous beliefs and their actual classroom practice. There appeared to be no correlation between high autonomy beliefs and any of the observed autonomous practices in teacher classrooms. This did not mean that practices did not occur, but there were no significant relationships identified in the data. This could be due to the fact that other classroom constraints or pressures cause actual practice to play out in a particular way. Teachers who scored in the moderate autonomy range did appear to provide more problem-solving opportunities to their students. There was also a significant correlation between moderate control and connections to learning. This is when teachers supported students by making explicit connections to real-world experiences, or making content relatable for students.

It is important to note that these correlations in the moderate range, either moderate autonomy or moderate control, are similar to findings in previous studies that found that both support and structure were needed in order for student to perceive autonomy support. This moderate support allows students to feel supported while still providing the necessary structure in a school setting. While this interpretation has to be made lightly as it is simply correlational in nature, it does appear to be similar to other findings.

When looking at the combined data from teacher interviews, metaphor analysis, survey responses and observed classroom practices, a belief/practice gap became evident. This finding was not surprising but confirmed other literature that acknowledges a discrepancy between teachers’ reported philosophies or beliefs and their actual classroom practice. This can be
contribute to a number of factors including district level policies and mandates, administrative support or lack thereof and other professional constraints. What is interesting to note about this finding is that the majority of work around self-determination theory, focuses on autonomy support and classrooms is survey-based at both the teacher and student level. By adding actual classroom observations which focused on teachers’ autonomous practices to the discussion, we were able to get a more nuanced picture of the role that autonomy actually played in both teacher practice and student engagement for this school environment. In this particular sample, student perception of autonomy appeared to be more important than the autonomous practices that teachers used, but additional study on a larger scale across multiple school settings would be needed to further validate these findings.

**Student Perceptions of Autonomy and Teacher Practice**

The third question focused on the relationship between student perceptions of autonomy and teacher practices. Based on the findings, there was a positive and significant correlation between students’ perception of autonomy and teacher’s beliefs about their autonomy and their autonomous practices. This appears to align with previous research on student perceptions of autonomy and teacher’s reported autonomy. While there appears to be a correlation between student perception and teacher autonomy, this does not demonstrate a causal relationship between the variables. It also does not help us to understand how teacher’s autonomy support or student’s perception of autonomy impacts their engagement with school or their attitudes towards STEM. In order to look more carefully at this impact, hierarchical linear modeling was used.
**Student and Teacher Level Effects on Student Engagement**

This fourth question focused on the impact of student perceptions and attitudes on student engagement. When looking at the analysis, both student perception of autonomy and student attitudes toward STAEM significantly predicted student engagement within classrooms. This would indicate that something about classroom settings helped students to feel a sense of autonomy. A third and final variable was added at the classroom level to examine the effects of teacher’s autonomous practices. While the hypothesis was that teacher practices would have an impact on student engagement, this was not supported by the data analysis. This could be an indication that there are other student characteristics, such as disposition, or environmental factors that are better predictors of student engagement in this particular STEAM environment. Other possible factors include the variety of opportunities and experiences that are provided to the students within the environment or even student’s awareness that they have access to additional opportunities if they choose to take part in them. It is difficult to separate the student’s overall experiences in the STEAM-focused school environment as a whole from their classroom experiences. In addition, students in fourth and fifth grades switched classes in this school setting. This meant that on a daily basis they received instruction from all teachers at that level. An attempt was made to have students focus on their homeroom teachers and the instruction they provided. However, it was difficult to control for this within the data.

**Limitations**

When examining the nature of this study, there are several limitations which can be found. This study focused on self-report measures from both teachers and students as the primary source of data collection. One potential issue with survey data is misinterpretation of the questions. By this, I mean that one may perceive the questions in a way that is not necessarily
intended by the item and responses offered. In addition, when surveying children, it is possible that they mark responses incorrectly. Issues of social desirable responses may have also been an issue with survey responses. Although precautions were taken to ensure correct data entry, there also could have been manual error with data entry and coding.

Sample size was also an issue with this study. The teacher sample consisted of only 8 teachers which made rich quantitative analysis impossible. The inclusion of several qualitative measures to describe and discuss the phenomena in this study was an attempt to address research questions in a meaningful way with a small sample size. While the student sample size was sufficient for the type of analysis performed, a larger student sample could have allowed for more variability in the data.

Generalizability was an additional limitation with this study due to the specific population. This study was conducted within one school setting with no comparison group and only a subset of teachers and students within this school setting. There is also no way to tell if there were significant differences between the students who did not participate in this study and those who did. Within each classroom, only about 40-50% of students actually participated in the study. It could be that these parents and students were more interested in the STEAM experience provided by the school and as a result students may have intrinsically had more positive attitudes about STEAM and a greater sense of autonomy. Extending findings to other school settings and populations that are not STEAM-focused could make the results more generalizable.

A final limitation is related to the method of data collection chosen for students. While survey data was an efficient way to collect student information, it did not allow for explanation of responses or more rich information from students. Students did not participate in focus groups or interviews, nor were they the focus of the observational data that was collected. While there
were some student-level engagement variables in the Teaching Dimensions Observation Protocol (TDOP), they were not the focus of this study. Additional analysis of these student-level factors within the TDOP could provide additional information about students’ engagement during instruction. In addition, a mixed-methods approach with students involving focus groups or follow-up interviews after survey collection may offer additional insight into how student perceptions of autonomy develop.

**Future Research**

One future direction is to understand additional variables that influence student engagement in an elementary STEAM environment. This might include an exploration of student dispositions related to STEAM or even exploring readiness for autonomy among elementary students. In addition, it could include a study of environmental factors that affect student engagement. This study suggests that student perceptions and attitudes are more relevant when it comes to engagement in STEAM environments, but are there more specific student characteristics that are related to student engagement. It may be interesting to explore whether student characteristics are school-focused or more related to community or familial issues.

Another future direction is focused on teachers and teacher practice. A larger study of teacher practices around STEAM instruction could provide additional evidence for best practices and lend itself to professional development opportunities for in-service teachers or curricular training for pre-service teachers. More specifically, does teachers’ own sense of autonomy impact their ability to support students? What pedagogical strategies best support students during STEAM instruction or project-based learning and how do best prepare teachers to consistently implement those strategies?
Because a belief/practice gap around autonomy support was identified within the data, it would be important to see if this gap is still prevalent in a larger population. It raises the importance of moving beyond survey reports when examining autonomy support and recognizing the relevance of including actual classroom practice in the discussion and design of future studies. While survey data has given us a great deal of information around autonomy support, the addition of observational data, allows us to think more deeply about practical applications of autonomy-support for teachers and gives us richer data to support them in their pedagogical development.

In order to more closely examine the impact of autonomous practices within particular content areas, a study could be designed that allowed for students to assess their perceived autonomy by class period. This would allow for a more in-depth look at teacher-specific practices by content area which could add another dimension to the data.

There are still several avenues to be explored related to teacher’s autonomy-supportive practices in elementary environments, particularly as they impact students in high poverty, predominantly minority settings.
REFERENCES


Morrison, J. (2006). Attributes of STEM education: The student, the school, the classroom. *TIES (Teaching Institute for Excellence in STEM)*.


December 14, 2016

Adriane Sheffield ESPRMC
College of Education Box 870326


Dear Ms. Sheffield:

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on December 12, 2017. If your research will continue beyond this date, please complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, please complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent and assent forms.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research. Sincerely,
UNIVERSITY OF ALABAMA

YOU ARE BEING ASKED TO PARTICIPATE IN A RESEARCH STUDY.


Investigator: Adriane Sheffield; Educational Psychology Doctoral Student

Institution: University of Alabama

Dear Educator,

I am writing to solicit your help with my doctoral dissertation research project. This research project is a required component for the completion of my doctoral degree.

What is this study about?
The purpose of this study is to look at how teacher’s underlying beliefs affect their classroom practice and how students engage with learning.

This study will examine 1) what teachers believe about how students learn and their role as teachers; 2) teacher’s instructional practices and; 3) how students’ participation in project-based learning impacts their attitudes about and engagement with STEM.

Why is this study important—What good will the results do?
Research tells us that teacher beliefs affect instruction. Therefore, it is important to learn more about what teachers believe, how their beliefs affect their practice and how students respond to those practices. I am hoping to contribute to this understanding with this research project.

Why have I been asked to participate in this study?
You are being asked to participate in this study because you are an educator in a school that emphasizes STEAM or project-based instruction.

What will I be asked to do in this study?
If you choose to participate, you will complete a semi-structured interview with Ms. Sheffield. You will receive the questions in writing ahead of time. You will use a computer to answer survey questions. The surveys are described below:

Epistemological Beliefs Instrument (EBI; Chen & Elliott, 2002) was designed to assess teacher’s beliefs about knowledge, knowing and learning.

The Problems in Schools Questionnaire (Deci, Schwartz, Sheinman & Ryan, 1981) was designed to assess a teacher’s style of authority.

The Behavior and Instructional Management Scale (BIMS; Martin & Sass, 2010) assesses teachers’ beliefs and attitudes about the management of instruction and people.

The Teacher Attitudes Toward STEM (T-STEM; FlE1, 2012). T-STEM is a measure developed to assess teacher’s self-efficacy in STEM content and teaching.

Teacher as Social Context Questionnaire (TASC-Q: Belmont, Skinner, Wellborn & Connell, 1988). TASC-Q was developed as a self-report measure to examine three areas of teacher behavior that impact student’s experiences in the classroom: structure, involvement and autonomy support. The subscales for structure and autonomy support will be used for this study.
You will also be observed and may be video-recorded on 3 different occasions during instructional time.

**How much time will I spend being in this study?**
The semi-structured interviews will take 30-45 minutes. The surveys should take no more than 45 minutes. Three 50-minute teaching observations will be completed during this study. You will spend a total of 4-5 hours in this study during the course of the 2016-17 school year.

**Will being in the study cost me anything?**
The only cost is your time.

**Will I be compensated for being in this study?**
There is no compensation for this study.

**What are the potential risks (problems or dangers) from being in this study?**
There is no risk associated with you taking part in this study.

**What are the potential benefits of being in this study?**
You may gain a greater awareness of your current teaching practices.

**How will my privacy be protected?**
When you answer the survey questions, you will not be asked to give your name. Only Ms. Sheffield will have access to the information you provide in the surveys and interviews. Your individual privacy will be maintained in all published and written data resulting from the study; no references will be made in any written or oral reports that could individually identify you.

**How will my confidentiality be protected?**
The only place where names will appear in connection with this study is on this informed consent. The consent forms will be kept in a locked file drawer in the university office, which is locked when no one is there. The internet-based data collection site for this study uses data encryption to guard against unauthorized access to your information. All audio files will be transferred to a password-protected desktop computer and secured in a password-protected file. Any original video recordings will be erased at the conclusion of this study.

**How will the information collected be used?**
A report summarizing our findings will be prepared for the school leaders and teachers. No personally identifying information will be included in this report. In addition, articles and presentations will be prepared to share at professional conferences and through written publications.

**What are the alternatives to being in this study?**
You are not required to be in this study. The alternative to being in this study is for you not to participate.
What are your rights as a participant?

Being in this study is totally voluntary. It is your free choice to participate. You may choose not to participate. If you start the study, you may stop at any time. If you decide to stop participating in the study, this will have no effect on your relationship with your school, your district or the University of Alabama.

The University of Alabama Institutional Review Board is a committee that looks out for the ethical treatment of people in research studies. They may review the study records if they wish. This is to be sure that people in research studies are being treated fairly and that the study is being carried out as planned.

Who do I contact if I have questions or problems?

If you have questions about this study right now, please ask them. If you have questions later on, please contact the investigator, Adriane Sheffield at asheffield1@crimson.ua.edu or Cecil Robinson, faculty advisor, at crobbino@ua.edu. If you have questions, concerns, or complaints about your rights as a research participant, call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll free as 1-877-820-3066 or by email at cmyles@ua.ua.edu.

You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at http://osp.ua.edu/site/PRCO_Welcome.html or email the Research Compliance Office at participantoutreach@bama.ua.edu.

After you participate, you are encouraged to complete the survey for research participants that is online at the outreach website or you may ask the investigator, Adriane Sheffield, for a copy of it and mail it to the University Office for Research Compliance, Box 870127, 358 Rose Administration Building, Tuscaloosa, AL 35487-0127.

You may keep a copy of this consent form for your records.

Please sign and return the signature page.
You are making a decision about participating in this study. Your signature below indicates that you have read the information provided above and have decided to participate in the study. If you later decide that you wish to withdraw your permission to participate in the study, simply tell me. You may discontinue your participation at any time.

I consent to participating in this study.

Please initial: _______ yes _______ no

I consent to my interview being audio-recorded.

Please initial: _______ yes _______ no

I consent to my observations being video-recorded.

Please initial: _______ yes _______ no

________________________
Printed Name

________________________
Signature

________________________
Date

________________________
Signature of person obtaining consent

________________________
Date
PARENT CONSENT FORM
UNIVERSITY OF ALABAMA

YOUR CHILD IS BEING ASKED TO PARTICIPATE IN A RESEARCH STUDY.

Investigator: Adriane Sheffield; Educational Psychology Doctoral Student

Institution: University of Alabama

You are being asked to give permission for your child to participate in a research study. The study is called "Dissertation: Autonomy Support in a STEAM Environment: Teacher Beliefs and Practices, Student Perceptions and Engagement." This study is being done by Adriane Sheffield, M.Ed., a doctoral student in the department of Educational Psychology at the University of Alabama and STEAM coordinator at University Place.

What is this study about?
The purpose of this study is to look at how teachers’ classroom practices influences student’s attitudes towards STEAM and their level of active participation in learning.

This study will examine how students participate in project-based learning, or STEAM, what students believe about their learning, and their attitudes towards STEAM and its impact on their school achievement.

Why is this study important—What good will the results do?
The results of this study will help those who work with students to understand how students respond to teacher’s instructional practices during project-based learning.

Why has your child been asked to participate in this study?
The staff at your child’s school believes that observing and asking 3rd, 4th and 5th graders what they think about school and learning is important. Your child is being asked to participate in this study because your child is in the 3rd, 4th or 5th right now.

How many other people will be in this study?
The investigator hopes to include about 150-200 3rd, 4th and 5th grade students

What will your child be asked to do in this study?
If you allow your child to participate, your child will answer sets of questions called surveys. The surveys are described below:

The Student Attitudes Toward STEM (S-STEM) Survey-modified measures changes in student’s attitudes about and confidence in STEM subjects, 21st century learning skills and their interest in STEM careers.

The Engagement vs. Disaffection Scale-Revised measures students’ thoughts and actions about participating in learning.
The Autonomy-Affecting Teacher Behaviors scale (Assor et al., 2002) assesses students' perceptions of their primary teacher’s behaviors, their feelings while studying various subjects and their perceived engagement with subject matter.

In addition, school-wide records (attendance, report card grades and achievement scores) will be reviewed. These records will provide a practical measure of participation, achievement and/or engagement at your child’s school.

**How much time will my child spend being in this study?**
The surveys should take no more than 45 minutes to complete.

**Will being in the study cost me or my child anything?**
The only cost is your child’s time.

**Will my child or I be compensated for being in this study?**
There will be no compensation for participating in this study.

**What are the risks (problems or dangers) to my child from being in this study?**
There is no risk associated with your child taking part in this study.

**What are the benefits of my child being in this study?**
There are no direct benefits to you or your child. However, you and your child may feel good about knowing that you have helped teachers learn how to better support your child’s learning of complex material.

**How will my child’s privacy be protected?**
Your child will answer the survey questions while in his or her classroom. When your child answers the survey questions, they will not be asked to give their name. Only the investigators will have access to the information your child provides in the surveys. Your child's individual privacy will be maintained in all published and written data resulting from the study. No references will be made in any written or oral reports that could individually identify your child.

**Your child’s name will NOT be connected to any school records (test scores, grades and attendance) that will be reviewed.**

**How will my child’s confidentiality be protected?**
The only place where names will appear in connection with this study is on this informed consent. The consent forms will be kept in a locked file drawer in the university office, which is locked when no one is there. Numerical information from school records will be maintained on a password-protected desktop computer and secured in a password-protected file. At the end of the study, all documents generated during the study (surveys, student records spreadsheet) will be destroyed.

**How will the information collected be used?**
A report summarizing our findings will be prepared for the school leaders and teachers. No personally identifying information will be included in this report. In addition, articles and
presentations will be prepared to share at professional conferences and through written publications.

What are the alternatives to my child being in this study?
Your child is not required to be in this study. The alternative to your child being in this study is for him or her NOT to participate.

What are your child’s rights as a participant?
Being in this study is totally voluntary. It is your free choice to allow your child to participate. You may choose not to allow your child to participate. If your child starts the study, he or she may stop at any time. If your child decides to stop participating in the study, this will have no effect on your relationship or your child’s relationship with University Place Elementary School or the University of Alabama. The University of Alabama Institutional Review Board is a committee that looks out for the ethical treatment of people in research studies. They may review the study records if they wish. This is to be sure that people in research studies are being treated fairly and that the study is being carried out as planned.

Who do I contact if I have questions or problems?
If you have questions about this study right now, please ask them. If you have questions later on, please contact the investigator, Adriane Sheffield at asheffield1@crimson.ua.edu or Cecil Robinson, faculty advisor, crobinso@ua.edu. If you have questions, concerns, or complaints about your child’s rights as a research participant, call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll free as 1-877-820-3066 or by email at cmyles@fa.ua.edu.

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After your child participates, you are encouraged to complete the survey for research participants that is online at the outreach website or you may ask the investigator, Adriane Sheffield, for a copy of it and mail it to the University Office for Research Compliance, Box 870127, 358 Rose Administration Building, Tuscaloosa, AL 35487-0127.

You may keep a copy of this consent form for your records.

PLEASE return the last page with signatures.
You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study, simply tell us. You may discontinue his or her participation at any time.

I consent for my child to participate in this study.
Please initial: _______ yes _______ no

I consent for my child's school records to be reviewed (attendance, grades, test scores).
Please initial: _______ yes _______ no

Printed Name of child

Homeroom

Signature of Parent(s) or Legal Guardian

Date

Signature of Parent(s) or Legal Guardian

Date

Signature of person obtaining consent

Date

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 12/13/16
EXPIRATION DATE: 12/12/17
Dear Student:

I am doing a study about how students learn in a STEAM school. This is a part of my classes at the University of Alabama. I want to learn more about what you think of your teachers and the ways you learn. This will help me to know what it is like for kids your age at a STEAM school. I hope that we can learn some new ways to make school more fun for students like you.

Your family knows I am asking you to be in this study. It is OK with them.

• I will ask you to answer some questions using surveys. This will take about 45 minutes.

• I will look at your report card grades, test scores and the number of days you attend school.

I would like your help with this study. You do not have to be in the study if you do not want to. It is your free choice. If you start the study and then decide that you don’t want to keep going, just let me know. No one will be mad at you.

No one will be able to tell what you said or did in this study. I will not tell your teachers or parents how you answered the questions. I will only talk about all of the kids together so no one knows who you are. If any of the questions I ask you make you feel bad or upset, just let me know. You will not have to answer those questions if you don’t want to.

After you complete the surveys, you will receive a Wendy’s frosty coupon as a thank you for your time.

If you have any questions about this study, you can ask them right now.

If you have decided that you do want to be in this study, please sign your name in the space below.

Thank you,

Adriane Sheffield, M.Ed., Researcher, STEAM Coordinator

I understand what I will do in this study and I agree to participate. (Please circle one)  yes  no

Name of Student ____________________________ Date __________

Person Obtaining Assent ____________________________ Date __________

UA IRB Approved Document
Approval date: 12-13-16
Expiration date: 12-12-17
Dear Principal,

As a part of the requirements for my doctoral degree in Educational Psychology at the University of Alabama, I am conducting a study exploring teachers’ beliefs and practices about autonomy support in a STEAM-focused environment. I would like to ask for your approval to survey, observe and interview your K-5th grade teachers. In addition, I would like to survey your 3rd-5th grade students about their experiences learning in a STEAM environment as well as their attitudes toward STEAM and learning in general. The purpose of this study will be to explore the beliefs and practices that teachers use to engage their students in STEAM activities and how students respond to those practices.

The time frame for this study will be from June 2016 to February 2017. I am asking for your teachers to participate in one individual interview, two observations (one scheduled, one unscheduled) and one set of online survey questions. First, teachers will be asked to complete survey questions using the Qualtrics online platform. Upon completion of surveys, teachers will participate in a face-to-face interview at a mutually agreed upon time and place. Prior to the interview, select questions will be given to them to review. I am providing a copy of the interview questions for you as well. During the interview, I may ask other questions for clarification. Finally, I would also like to, at a time that is convenient for you and your teachers, observe the teachers during STEAM instruction in the fall semester of the school year. I will be audio-recording the interviews and video-recording the observations so I can transcribe them and ensure accuracy of all data collected. All information during the interviews, observations and surveys will be kept confidential. Each participant in this study will be assigned a pseudonym to protect their anonymity.

3rd-5th grade students will be asked to complete surveys during their computer lab time on a day identified by their teachers so as not interfere with academic instructional time. All information from student surveys will be kept confidential. Student id numbers will be assigned to protect anonymity.

The data from this research will be shared with the University of Alabama's College of Education. If you are interested, I would be happy to share the findings of the study with you when it is completed. There are no known threats or risks to the participants in this study. The teachers and students will have the option to withdraw from this study at any time without repercussions.

It is your right to have any questions regarding teacher participation answered. If you have any questions or want further information regarding the purpose of this study, please contact me at ansheffieldl@crimson.ua.edu or asheffield@tusc.k12.al.us.
Respectfully,

Adriane Sheffield

Your signature below indicates that you give your approval for this study to be conducted.

Signature

1 \ Date
Teacher Demographic Questionnaire

Please complete the following information:

1. Grade level you are now teaching: 1
   ____________
   2  ____________
   3  ____________
   4  ____________
   5  ____________

2. Gender: F
   M  ______

3. Ethnicity:
   African-American  ______
   Caucasian  ______
   Hispanic  ______
   Other  ______

4. Years teaching experience at elementary level: _______ years

5. Years teaching experience at current school: _______ years

6. Years total teaching experience: _______ years

7. Highest degree earned:
   BA/BS ______ area: ____________________________
   MS/MA ______ area: ____________________________
   Specialist (Ed. S.) ______ area: ____________________________
   Doctorate ______ area: ____________________________

8. How often do you teach/facilitate STEAM lessons in your classroom? select one
   rarely
   1-2x a week
   3-4x a week
daily

9. How often do community partners facilitate STEAM lessons in your classroom?
   rarely
   1-2x a week
   3-4x a week
daily

10. Which of the following strategies do you currently use in your classroom?
    (please check all that apply)
--integrate ELA, science, math and/or social studies standards
--allow students to choose how they will demonstrate their learning/understanding
--hands-on manipulatives
--clearly articulate the real-world uses of their learning (explain relevance of skill/content)
--allows for multiple responses/solutions to a problem
--encourage collaboration and communication with peers
--allow students to revise/refine their work
--guide students through the engineering design process
--make connections across content areas
--learning centers
--worksheets
--online learning (educational websites, podcasts, etc.)

Teacher Interview Protocol Adapted from Teachers Belief Interview (Luft & Roerhig, 2007)

1. How do you maximize student learning in your classroom? (learning)
2. How do you describe your role as a teacher? (knowledge)
3. How do you know when your students understand? (learning)
4. In the school setting, how do you decide what to teach and what not to teach? (knowledge)
5. How do you decide when to move on to a new topic in your classroom? (knowledge)
6. How do your students learn science or math best? (learning)
7. How do you know when learning is occurring in your classroom? (learning)
8. Please describe autonomy.
9. How important is it for a student to have a sense of autonomy in the classroom? Please explain.
10. How important is it for you to support autonomy within your students? Please explain.
11. What do you believe is the most important skill for students to develop in the 21st century and why?
12. If I were to provide feedback after observing your lessons, what type of feedback would be most useful to you?
13. How would you choose to structure your lessons within a STEAM context?

Epistemological Beliefs Inventory (Chan & Elliot, 2002)

1. There isn’t much you can do to make yourself smarter as your ability is fixed at birth.
2. Our abilities to learn are fixed at birth.
3. One’s innate ability limits what one can learn.
4. Some people are born good learners, others are just stuck with limited ability.
5. Some children are born incapable of learning well in certain subjects.
6. The ability to learn is innate/inborn.
7. Students who begin school with “average” ability remain “average” throughout school.
8. The really smart students don’t have to work hard to do well in school.
9. People who challenge authority’s knowledge are over-confident.
10. You can believe most things you read in textbooks written by famous scholars as they are usually subject experts.
11. Nothing is certain and absolute.
12. If people can’t understand something right away, they should keep on trying.
13. Knowing how to learn is more important than the acquired facts.
14. One learns little if one does not work hard.
15. Understanding course materials and thinking process are more important than acquiring knowledge/facts.
16. Everyone needs to learn how to learn.
17. People will learn better if they focus more on the process of understanding rather than the facts to be acquired.
18. Learning something really well takes a long time or much effort.
19. How much you get from your learning depends mostly on your effort.
20. Getting ahead takes a lot of work.
21. If one tires hard enough, then one will understand the course material.
22. Wisdom is not knowing the answers, but knowing how to find the answers.
23. Most problems have one best solution no matter how difficult they are.
24. If people find the time to re-read a textbook chapter, they will learn new things the second time.
25. The most successful learners have discovered how to learn.
26. Sometimes, I don’t believe the facts in textbooks written by authorities.
27. Even advice from experts should often be questioned.
28. I often wonder how much experts really know.
29. Knowledge is tentative and uncertain, because it is always “changing.”
30. I am very aware that teachers/lecturers know a lot more than I do and so I agree with what they say is important rather than rely on my own judgment.
31. I still believe in what the experts say even though it differs from what I know.
32. I have no doubts in whatever the experts say.
33. Scientists will ultimately get to the truth if they keep searching for it.
34. If scientists try hard enough, they can find the truth to almost anything.
35. Anyone can figure out difficult concepts if one works hard enough.
36. I believe there should exist a teaching method applicable to all learning situations.
37. Scientific knowledge is certain and does not change.
38. There is a definite answer to every problem.

**Behavior and Instructional Management Scale (Martin & Sass, 2010)**

1. I nearly always intervene when students talk at inappropriate times during class.
2. I strongly limit student chatter in the classroom.
3. I nearly always use collaborative learning to explore questions in the classroom.
4. I engage students in active discussion about issues related to real world applications.
5. I nearly always use group work in my classroom.
6. I use student input when creating student projects.
7. I firmly redirect students back to topic when they get off task.
8. I insist that students in my classroom follow the rules at all times.
9. I nearly always adjust instruction in response to individual student needs.
10. I strictly enforce classroom rules to control student behavior.
11. If a student’s behavior is defiant, I will demand that they comply with my classroom rules.
12. I nearly always use a teaching approach that encourages interaction among students.

Problem in Schools Questionnaire

A. Jim is an average student who has been working at grade level. During the past two weeks he has appeared listless and has not been participating during reading group. The work he does is accurate but he has not been completing assignments. A phone conversation with his mother revealed no useful information. The most appropriate thing for Jim’s teacher to do is:

1. She should impress upon him the importance of finishing his assignments since he needs to learn this material for his own good.
2. Let him know that he doesn’t have to finish all of his work now and see if she can help him work out the cause of the listlessness.
3. Make him stay after school until that day’s assignments are done.
4. Let him see how he compares with the other children in terms of his assignments and encourage him to catch up with the others.

B. At a parent conference last night, Mr. and Mrs. Greene were told that their daughter Sarah has made more progress than expected since the time of the last conference. All agree that they hope she continues to improve so that she does not have to repeat the grade (which the Greene’s have been kind of expecting since the last report card). As a result of the conference, the Greenes decide to:

5. Increase her allowance and promise her a ten-speed if she continues to improve.
6. Tell her that she’s now doing as well as many of the other children in her class.
7. Tell her about the report, letting her know that they’re aware of her increased independence in school and at home.
8. Continue to emphasize that she has to work hard to get better grades.

C. Donny loses his temper a lot and has a way of agitating other children. He doesn’t respond well to what you tell him to do and you’re concerned that he won’t learn the social skills he needs. The best thing for you to do with him is:

9. Emphasize how important it is for him to “control himself” in order to succeed in school and in other situations.
10. Put him in a special class which has the structure and reward contingencies which he needs.
11. Help him see how other children behave in these various situations and praise him for doing the same.
12. Realize that Donny is probably not getting the attention he needs and start being more responsive to him.

D. Your son is one of the better players on his junior soccer team which has been winning most
of its games. However, you are concerned because he just told you he failed his unit spelling test and will have to retake it the day after tomorrow. You decide that the best thing to do is:

13. Ask him to talk about how he plans to handle the situation.
14. Tell him he probably ought to decide to forego tomorrow’s game so he can catch up in spelling.
15. See if others are in the same predicament and suggest he do as much preparation as the others.
16. Make him miss tomorrow’s game to study; soccer has been interfering too much with his school work.

E. The Rangers spelling group has been having trouble all year. How could Miss Wilson best help the Rangers?

17. Have regular spelling bees so that Rangers will be motivated to do as well as the other groups.
18. Make them drill more and give them special privileges for improvements.
19. Have each child keep a spelling chart and emphasize how important it is to have a good chart.
20. Help the group devise ways of learning the words together (skits, games, and so on).

F. In your class is a girl named Margy who has been the butt of jokes for years. She is quiet and usually alone. In spite of the efforts of previous teachers, Margy has not been accepted by the other children. Your wisdom would guide you to:

21. Prod her into interactions and provide her with much praise for any social initiative.
22. Talk to her and emphasize that she should make friends so she’ll be happier.
23. Invite her to talk about her relations with the other kids, and encourage her to take small steps when she’s ready.
24. Encourage her to observe how other children relate and to join in with them.

G. For the past few weeks things have been disappearing from the teacher’s desk and lunch money has been taken from some of the children’s desks. Today, Marvin was seen by the teacher taking a silver dollar paperweight from her desk. The teacher phoned Marvin’s mother and spoke to her about this incident. Although the teacher suspects that Marvin has been responsible for the other thefts, she mentioned only the one and assured the mother that she’ll keep a close eye on Marvin. The best thing for the mother to do is:

25. Talk to him about the consequences of stealing and what it would mean in relation to the other kids.
26. Talk to him about it, expressing her confidence in him and attempting to understand why he did it.
27. Give him a good scolding; stealing is something which cannot be tolerated and he has to learn that.
28. Emphasize that it was wrong and have him apologize to the teacher and promise not to do it again.

H. Your child has been getting average grades, and you’d like to see her improve. A useful approach might be to:
29. Encourage her to talk about her report card and what it means for her.
30. Go over the report card with her; point out where she stands in the class.
31. Stress that she should do better; she’ll never get into college with grades like these.
32. Offer her a dollar for every A and 50 cents for every B on future report cards.

**T-STEM**

*For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.*

**Science Teaching Efficacy and Beliefs**
Directions: Please respond to these questions regarding your feelings about your own teaching.
1. I am continually improving my science teaching practice.
2. I know the steps necessary to teach science effectively.
3. I am confident that I can explain to students why science experiments work.
4. I am confident that I can teach science effectively.
5. I wonder if I have the necessary skills to teach science.
6. I understand science concepts well enough to be effective in teaching science.
7. Given a choice, I would invite a colleague to evaluate my scienceteaching.
8. I am confident that I can answer students’ science questions.
9. When a student has difficulty understanding a science concept, I am confident that I know how to help the student understand it better.
10. When teaching science, I am confident enough to welcome student questions.
11. I know what to do to increase student interest in science.

**Science Teaching Outcome Expectancy**
Directions: The following questions ask about your feelings about teaching in general. Please respond accordingly.
1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
2. The inadequacy of a student’s science background can be overcome by good teaching.
3. When a student’s learning in science is greater than expected, it is most often due to their teacher having found a more effective teaching approach.
4. The teacher is generally responsible for students’ learning in science.
5. If students’ learning in science is less than expected, it is most likely due to ineffective science teaching.
6. Students’ learning in science is directly related to their teacher’s effectiveness in science teaching.
7. When a low achieving child progresses more than expected in science, it is usually due to extra attention given by the teacher.
8. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child’s teacher.
9. Minimal student learning in science can generally be attributed to their teachers.
Mathematics Teaching Efficacy and Beliefs
Directions: Please respond to these questions regarding your feelings about your own teaching.
1. I am continually improving my mathematics teaching practice.
2. I know the steps necessary to teach mathematics effectively.
3. I am confident that I can explain to students why mathematics experiments work.
4. I am confident that I can teach mathematics effectively.
5. I wonder if I have the necessary skills to teach mathematics.
6. I understand mathematics concepts well enough to be effective in teaching mathematics.
7. Given a choice, I would invite a colleague to evaluate my mathematics teaching.
8. I am confident that I can answer students’ mathematics questions.
9. When a student has difficulty understanding a mathematics concept, I am confident that I know how to help the student understand it better.
10. When teaching mathematics, I am confident enough to welcome student questions.
11. I know what to do to increase student interest in mathematics.

Mathematics Teaching Outcome Expectancy
Directions: The following questions ask about your feelings about teaching in general. Please respond accordingly.
1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2. The inadequacy of a student’s mathematics background can be overcome by good teaching.
3. When a student’s learning in mathematics is greater than expected, it is most often due to their teacher having found a more effective teaching approach.
4. The teacher is generally responsible for students’ learning in mathematics.
5. If students’ learning in mathematics is less than expected, it is most likely due to ineffective mathematics teaching.
6. Students’ learning in mathematics is directly related to their teacher’s effectiveness in mathematics teaching.
7. When a low achieving child progresses more than expected in mathematics, it is usually due to extra attention given by the teacher.
8. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child’s teacher.
9. Minimal student learning in mathematics can generally be attributed to their teachers.

During elementary STEAM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), how often do your students…

Elementary STEAM Instruction

1. Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations).
2. Work in small groups.
3. Make predictions that can be tested.
4. Make careful observations or measurements.
5. Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.).
6. Recognize patterns in data.
7. Create reasonable explanations of results of an experiment or investigation.
8. Choose the most appropriate methods to express results (e.g. drawings, models, charts,
graphs, technical language, etc.).
9. Complete activities with a real-world context.
12. Reason quantitatively.
13. Critique the reasoning of others.
14. Learn about careers related to the instructional content.
15. Think creatively to design something new.
16. Design a model or representation of their learning.
17. Use, art, music or design to represent their understanding.

21st Century Learning Attitudes

 Directions: Please respond to the following questions regarding your feelings about learning in general.
“I think it is important that students have learning opportunities to…”

1. Lead others to accomplish a goal.
2. Encourage others to do their best.
3. Produce high quality work.
4. Respect the differences of their peers.
5. Help their peers.
6. Include others’ perspectives when making decisions.
7. Make changes when things do not go as planned.
8. Set their own learning goals.
9. Manage their time wisely when working on their own.
10. Choose which assignment out of many needs to be done first.
11. Work well with students from different backgrounds.

STEAM Career Awareness

 Directions: Please respond to the following questions based upon how much you disagree or agree with the statements.
“I know …”
1. About current STEAM careers.
2. Where to go to learn more about STEAM careers.
3. Where to find resources for teaching students about STEAM careers.
4. Where to direct students or parents to find information about STEAM careers.

Student Measures

 TASCQ-student report short form
1. My teacher doesn’t make it clear what he/she expects of me in class.
2. My teacher doesn’t tell me what she expects of me in school.
3. My teacher shows me how to solve problems for myself.
4. If I can’t solve a problem, my teacher shows me different ways to try to.
5. My teacher makes sure I understand before she goes on.
6. My teacher checks to see if I’m ready before she starts a new topic.
7. My teacher gives me a lot of choices about how I do my schoolwork.
8. My teacher doesn’t give me much choice about how I do my schoolwork.
9. My teacher is always getting on my case about schoolwork.
10. It seems like my teacher is always telling me what to do.
11. My teacher listens to my ideas.
12. My teacher doesn’t listen to my opinion.
13. My teacher talks about how I can use the things we learn in school.
14. My teacher doesn’t explain why what I do in school should be important to me.

**Autonomy-Affecting Teacher Behaviors**

*Questionnaire (items adapted from Assor, Kaplan, and Roth, 2002)*

**Providing choice**
1. When I am doing something that interests me, my teacher gives me enough time to finish it.
2. My teacher allows me to choose how to do my work in the classroom.
3. My teacher asks us which topics we would like to read more about and which ones we prefer to read less.
4. My teacher allows me to choose to read topics that interest me.
5. My teacher allows me to choose what questions I want to ask about a book or a topic.
6. When my teacher gives us an assignment she allows us to choose which questions to answer.

**Fostering relevance**
7. My teacher talks about the connection between what we study in school and what happens in real life.
8. It is important to my teacher that I would learn things that interest me.
9. My teacher explains why it is important to study certain subjects in school.
10. My teacher talks about how we feel concerning the topics we read and learn.
11. My teacher helps me understand how my questions help me read better.

**Allowing criticism and encouraging independent thinking**
12. My teacher encourages me to work in my own way.
13. My teacher shows me how to solve problems by myself.
14. It is important to my teacher that I ask my own questions about books.
15. My teacher listens to my opinions and ideas.
16. My teacher respects students who tell her what they really think and are not only trying to please her.
17. My teacher allows me to do certain things by myself.

**Intruding**
18. My teacher tells me what to do all the time.
19. My teacher does not allow me to work at my own pace.
20. My teacher is strict about me doing everything in her own way.
21. Sometimes I want to work on one topic and the teacher tells me I have to move to another topic.
22. Sometimes I want to move to a new topic and my teacher tells me to keep working on
the “old” topic.
24. My teacher stops me in the middle when I am writing or reading interesting things.

Forcing meaningless and uninteresting activities:
25. My teacher forces me to prepare uninteresting homework.
26. My teacher forces me to read boring things (books, stories or instructions).
27. My teacher forces me to participate in aggravating discussions.
28. My teacher forces me to complete work sheets that do not help me to understand the material we study.

Engagement Scale
(Items adapted from Skinner, Furrer, Marchand, & Kindermann, 2009; Jang, Kim & Reeve, 2016)

Behavioral engagement
1. When I'm in this class, I listen very carefully.
2. I pay attention in this class.
3. I try hard to do well in this class.
4. In this class, I work as hard as I can.
5. When I'm in this class, I participate in class discussions.

Behavioral disengagement
1. When I'm in this class, I just act like I'm working.
2. I don't try very hard in this class.
3. In this class, I do just enough to get by.
4. When I'm in this class, I think about other things.
5. When I'm in this class, my mind wanders.

Emotional engagement
1. When we work on something in this class, I feel interested.
2. This class is fun.
3. I enjoy learning new things in this class.
4. When I'm in this class, I feel good.
5. When we work on something in this class, I get involved.

Emotional disengagement
1. When we work on something in this class, I feel bored.
2. This class is no fun for me.
3. When I am in this class, I feel bad.
4. When I'm in this class, I feel worried.
5. When we work on something in this class, I feel discouraged.

Cognitive engagement
1. I study at home even when I don’t have a test.
2. I read extra books to learn more about things we do in school.
3. I check my schoolwork for mistakes.
4. I try to watch TV shows about things we are doing in school.

Cognitive disengagement
1. During class, I often don't know what to study or where to start.
2. During class, I find it difficult to organize my work.
3. When working in class, I have trouble figuring out what to do to learn.
Math engagement
1. I study my math facts even when I don’t have a test.
2. I check my math work for mistakes.
3. I try to apply the math I am learning at school to the real world.
4. During math, I often don’t know what to study or where to start.
5. During math lessons, I find it difficult to organize my work.
6. When working on math, I have trouble figuring out what to do to learn.

Science engagement
1. I study science topics at home even when I don’t have a test.
2. I check my science work for mistakes.
3. I try to apply the science I am learning at school to the real world.
4. During science, I often don’t know what to study or where to start.
5. During science lessons, I find it difficult to organize my work.
6. When working on science, I have trouble figuring out what to do to learn.

STEAM engagement
1. I design my own projects at home to practice what I am learning at school.
2. I learn from my mistakes and improve on my designs.
3. I apply the things I am learning at school to the real world.
4. I think about how I can apply what I am learning at school to my future career.
5. I find STEAM projects difficult to organize.
6. I often don’t know where to start when I am working on projects.
7. When working on STEAM projects, I have trouble figuring out what to do to learn.

DIRECTIONS:
There are lists of statements on the following pages. Please mark your answer sheets by marking how you feel about each statement. For example:

<table>
<thead>
<tr>
<th>Example 1:</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like engineering.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

As you read the sentence, you will know whether you agree or disagree. Fill in the circle that describes how much you agree or disagree.

Even though some statements are very similar, please answer each statement. This is not timed; work fast, but carefully.

There are no "right" or "wrong" answers! The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

PLEASE FILL IN ONLY ONE ANSWER PER QUESTION.
## Math

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Math has been my worst subject.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. When I’m older, I might choose a job that uses math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. Math is hard for me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4. I am the type of student who does well in math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>5. I can understand most subjects easily, but math is difficult for me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6. In the future, I could do harder math problems.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>7. I can get good grades in math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>8. I am good at math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

## Science

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. I feel good about myself when I do science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>10. I might choose a career in science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>11. After I finish high school, I will use science often.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>12. When I am older, knowing science will help me earn money.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>13. When I am older, I will need to understand science for my job.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>14. I know I can do well in science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>15. Science will be important to me in my future career.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>16. I can understand most subjects easily, but science is hard for me to understand.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>17. In the future, I could do harder science work.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Engineering**
**and**
**Technology**

Please read this paragraph before you answer the questions.

**Engineers** use math and science to invent things and solve problems. Engineers design and improve things like bridges, cars, machines, foods, and computer games. **Technologists** build, test, and maintain (or take care of) the designs that engineers create.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. I like to imagine making new products.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>19. If I learn engineering, then I can improve things that people use every day.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>20. I am good at building or fixing things.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>21. I am interested in what makes machines work.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>22. Designing products or structures will be important in my future jobs.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>23. I am curious about how electronics work.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>24. I want to be creative in my future jobs.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>25. Knowing how to use math and science together will help me to invent useful things.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>26. I believe I can be successful in engineering.</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
<td>○ ○ ○ ○ ○</td>
</tr>
</tbody>
</table>
## 21st Century Learning

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. I can lead others to reach a goal.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>28. I like to help others do their best.</td>
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<tr>
<td>29. In school and at home, I can do things well.</td>
<td></td>
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</tr>
<tr>
<td>30. I respect all children my age even if they are different from me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>31. I try to help other children my age.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. When I make decisions, I think about what is good for other people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. When things do not go how I want, I can change my actions for the better.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>34. I can make my own goals for learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>35. I can use time wisely when working on my own.</td>
<td></td>
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<tr>
<td>36. When I have a lot of homework, I can choose what needs to be done first.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. I can work well with all students, even if they are different from me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Your Future

Below is a list of types of work that you could do when you are older. As you read about each type of work, you will know if you think that work is interesting. Fill in the circle under the words that describe how interested you are in doing that when you are older.

There are no “right” or “wrong” answers. The only correct responses are those that are true for you.

<table>
<thead>
<tr>
<th></th>
<th>Not at all Interested</th>
<th>Not So Interested</th>
<th>Interested</th>
<th>Very Interested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physics: People study motion, gravity and what things are made of. They also study energy, like how a swinging bat can make a baseball switch directions. They study how different liquids, solids and gas can be turned into heat or electricity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. **Environmental Work:** People study how nature works. They study how waste and pollution affect the environment. They also invent solutions to these problems.

3. **Biology:** People work with animals and plants and how they live. They also study farm animals and the food that they make, like milk. They can use what they know to invent products for people to use.

4. **Veterinary Work:** People who prevent disease in animals. They give medicines to help animals get better and for animal and human safety.

5. **Mathematics:** People use math and computers to solve problems. They use it to make decisions in businesses and government. They use numbers to understand why different things happen, like why some people are healthier than others.

6. **Medicine:** People learn how the human body works. They decide why someone is sick or hurt and give medicines to help the person get better. They teach people about health, and sometimes they perform surgery.

7. **Earth Science:** People work with the air, water, rocks and soil. Some tell us if there is pollution and how to make the earth safer and cleaner. Other earth scientists forecast the weather.

8. **Computer Science:** People write instructions to run a program that a computer can follow. They design computer games and other programs. They also fix and improve computers for other people.

9. **Medical Science:** People study human diseases and work to find answers to human health problems.

10. **Chemistry:** People work with chemicals. They invent new chemicals and use them to make new products, like paints, medicine, and plastic.
11. **Energy/Electricity:** People invent, improve and maintain ways to make electricity or heat. They also design the electrical and other power systems in buildings and machines.

<table>
<thead>
<tr>
<th></th>
<th>O</th>
<th>O</th>
<th>O</th>
<th>O</th>
</tr>
</thead>
</table>

12. **Engineering:** People use science, math and computers to build different products (everything from airplanes to toothbrushes). Engineers make new products and keep them working.

<table>
<thead>
<tr>
<th></th>
<th>O</th>
<th>O</th>
<th>O</th>
<th>O</th>
</tr>
</thead>
</table>

### About Yourself

1. How well do you expect to do this year in your:

<table>
<thead>
<tr>
<th>Class</th>
<th>Not Very Well</th>
<th>OK/Pretty Well</th>
<th>Very Well</th>
</tr>
</thead>
<tbody>
<tr>
<td>English/Language Arts Class?</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Math Class?</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Science Class?</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

2. Do you know any adults who work as scientists?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Do you know any adults who work as engineers?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Do you know any adults who work as mathematicians?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Do you know any adults who work as technologists?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
On this cover sheet please fill in information about the purpose of the observation, instructor characteristics, and course characteristics. Some of this information will require a meeting/interview with the observed instructor, which is optional but recommended.

I. Observer Information

1) Observer name:  
2) Date and time of observation:  

IIa. Instructor Characteristics

1) Instructor id:  
2) Years teaching:  

III. Course Characteristics

1) Class name and grade level:  
2) What is the total number of students in the class at the time of the observation?  
3) Please describe the physical layout of the room (e.g., type of student seating, technology directly accessible by students)  
4) Please note if there is anything unusual about this particular class/lecture (e.g., quiz day, first day of semester, etc)  

**Code Definitions & Coding Rules**

**Teaching Methods**

**Teacher-focused instruction (teacher is the primary actor)**

**L Lecturing**: The instructor is talking to the students and not using visuals, demonstration equipment, actively writing, or asking more than 2 questions in a row in a Socratic manner.

**LW Lecturing while writing**: The instructor is talking to the students while actively writing on a chalkboard, transparencies, digital tablet, or other material. The instructor must either be writing or referring to what they are writing (or have already written). This code also captures real-time drawing of graphics (e.g., molecular structure, physiological processes), and if the use of visual representations is of interest, this should be included in the notes section. (Note that this code also captures writing/drawing in front of students without speaking, as a separate code for silent writing was deemed superfluous).

**LVIS Lecturing from pre-made visuals**: The instructor is talking to the students while referencing visual aides, such as slides, transparencies, posters, or models (e.g., plastic model of molecular structure, examples of sedimentary rocks, multimedia). The instructor must be referring to the topic contained in the visual, but the visual serves only as a reference point for the material and not as a live demonstration of phenomenon.

**LDEM Lecturing with demonstration of phenomena**: The instructor actively uses equipment (e.g., lab equipment, computer simulation) to convey course content. The objects must be in active use in relation to the topic and must be used for more than a simple reference point (e.g., “here is an
example of a sedimentary rock”) to demonstrate a process or phenomenon in class (e.g., “here is how sedimentary rock erodes over time” while physically demonstrating this process).

**SOC-L Socratic lecture**: The instructor is talking to the students while asking multiple, successive questions to which the students are responding. Student responses are either guiding or being integrated within the discussion. A minimum of 2 relevant student responses is required to use this code. (Note that SOC-L can be co-coded with other types of lecturing, such as LW, if the instructor is doing both writing AND interspersing his/her talk with questions).

**WP Working out problems**: This code refers to the instructor working out computations or problems. These can include balancing a chemical equation, working out a mathematical proof, or designing equations or Punnett squares, etc. The intent of the code is to capture the working through of some sort of problems in front of students. (If the computations/problems are on a slide and the instructor is actively working through problems, then this will be co-coded with LVIS. If this process is being written out, then this code will be co-coded with LW, and if students are being asked to participate in the problem-solving process via questions, code SOC-L).

**IND Individualized instruction**: The instructor provides instruction to individuals or groups and not the entire class. This often occurs while the instructor is roaming the classroom, but students or small groups may also approach the instructor. This code is usually co-coded with SGW or DW (see below). It is important to recognize that this code should not be used to classify the types of student-teacher interactions that are occurring in a large class setting – instead, use this code only when students are engaged in SGW or DW and the instructor is directly interacting with one or more students.

**MM Multimedia**: The instructor plays a video or movie (e.g., Youtube or documentary) without speaking while the students watch. If the instructor is talking over a video, movie, or simulation, then co-code with LVIS.

**A Assessment**: The instructor is explicitly gathering student learning data in class (e.g., tests, quizzes, or clickers).

**AT Administrative task**: The instructor is discussing exams, homework, or other non-content related topics.

**Student-focused instruction (students are the primary actor)**

**SGW Small group work/discussion**: Students form into groups of 2+ for the purposes of discussion and/or to complete a task.

**DW Deskwork**: Students complete work alone at their desk/chair.

**SP Student presentation**: Groups or individual students are giving to the class or are otherwise acting as the primary speaker or instructor in the classroom. In this instance, only select this code and none others as long as the primary instructor is not actively taking the lead in teaching the class.

**Student-Teacher Dialogue**

**Teacher-led dialogue**

**IRQ Instructor rhetorical question**: The instructor asks a question without seeking an answer and without giving students an opportunity to answer the question.

**IDQ Instructor display question**: The instructor poses a question seeking information. These questions can: seek a specific fact, a solution to a closed-ended problem, or involve students generating their own ideas rather than finding a specific solution.

**ICQ Instructor comprehension question**: The instructor checks for understanding (e.g., “Does that make sense?”) and pauses for at least five seconds, thereby indicating an opportunity for students to respond.

**Student-led dialogue**

**SQ Student question**: A student poses a question to the instructor that seeks new information (i.e. not asking to clarify a concept that was previously being discussed) and/or clarification of a concept that is part of the current or past class period.

**SR Student response to teacher question**: A student responds to a question posed by the instructor, whether posed verbally by the instructor or through digital means (e.g., clicker, website).

**PI Peer interactions**: Students speaking to one another (often during SGW, WCD, or SP).

**Instructional Technology**

**CB Chalkboard/whiteboard/Smart Board**
Overhead projector/transparencies
PowerPoint or other digital slides
Clicker response systems
Demonstration equipment: These could include chemistry demonstrations of reactions, physics demonstrations of motion, or any other material being used for the demonstration of a process or phenomenon. The objects must be in active use in relation to the topic. This can also include objects such as rocks being passed around a classroom.
Digital tablet: This refers to any technology where the instructor can actively write on a document or graphic that is being projected onto a screen. This includes document cameras as well as software on a laptop that allows for writing on PDF files.
Movie, documentary, video clips, or Youtube video
Simulation: Simulations can be digital applets or web-based applications.
Website: Includes instructor interaction with course website or other online resource (besides Youtube videos). This can include using a website for student responses to questions (in lieu of clickers).

Pedagogical Strategies
Humor: The instructor tells jokes or humorous anecdotes; this code requires laughter from at least a couple of students.
Anecdote/example: The instructor gives examples (either verbally through illustrative stories or graphically through movies or pictures) that clearly and explicitly link course material to (a) popular culture, the news, and other common student experiences, or (b) widely recognized cases or incidents that illustrate the abstract (both types are co-coded with CNL).
Organization: The instructor writes or posts an outline of class (i.e., advance organizer) or clearly indicates a transition from one topic to the next verbally or through transitional slides. This transition from one topic to another can indicate a change in topics within a single class or from a previous class to the present class. These transitions must be verbally explicit statements to the class (e.g., “Now we’re moving from meiosis to mitosis”) as opposed to ambiguous statements such as “Now we’ll pick up where we left off on Monday.” This may also include statements concerning how concepts covered in different portions of the class (e.g., lecture, homework and lab) may overlap.
Emphasis: The instructor clearly states that something is important for students to learn or remember for a test, for their future careers, or to just learn the material well
Relevance: The instructor clearly states that something is important for students to learn for their future careers, more advanced coursework, future life
Choice: The instructor offers students choices about their small group members, their instructional materials and provide students opportunities to demonstrate their understanding in their own way.

Optional Dimensions
Potential Student Cognitive Engagement
Making connections to own lives/specific cases: Students are given examples (either verbally through illustrative stories or graphically through movies or pictures) that clearly and explicitly link course material to popular culture, the news, and other common student experiences. Students may also be given specific cases or incidents in order to link an abstract principle or topic (e.g., flooding) with a more readily identifiable instance (e.g., 2013 floods in Boulder, Colorado). For this code to be used, the observer will need to make a judgment that the specific case is something meaningful to students, such as a local historic item or location, or a widely recognized incident. In general, a high bar is required here that is based on specificity and salience to students, such that showing a picture of a sedimentary rock will not be sufficient for this code, but if the picture was of the Grant Canyon and named as such, it would be coded as CNL. This code will be particularly important in biology (e.g., Dolly the sheep) and geoscience courses.
Problem solving: Students are asked to actively solve a problem (e.g., balance a chemical equation, work out a mathematical equation/algorithm). This is evident through explicit verbal (e.g., “Please solve for X”) or written requests (e.g., worksheet) to solve a problem.

This is coded in relation to closed-
ended exercises or problems where the instructor has a specific solution or end-point clearly in mind.

**Creating** (CR): Students are provided with tasks or dilemmas where the outcome is open-ended rather than fixed (e.g., students are asked to generate their own ideas and/or products rather than finding a specific solution). The task can be delivered verbally or in written form. **This is coded in relation to open-ended exercises or problems where the instructor does not have a specific solution or end-point clearly in mind**

**Student Engagement**

**VHI Very High:** More than 75% of the students in the immediate area of the observer are either (a) actively taking notes, or (b) looking at the instructor/course materials

**HI High:** Between 50% and 75% of the students in the immediate area of the observer are either (a) actively taking notes, or (b) looking at the instructor

**MED Medium:** Between 25% and 50% of the students in the immediate area of the observer are either (a) actively taking notes, or (b) looking at the instructor

**LO Low:** Less than 25% of the students in the immediate area of the observer are either (a) actively taking notes, or (b) looking at the instructor

**Directions:** Circle codes for each behavior observed during every two-minute interval. Take detailed notes about aspects of the class that is of particular interest for your application (e.g., content discussed, nature of student dialogue).

<table>
<thead>
<tr>
<th>Interval #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>0-1:59</td>
<td>2:00-3:59</td>
<td>4:00-5:59</td>
<td>6:00-7:59</td>
<td>8:00-9:59</td>
</tr>
<tr>
<td></td>
<td>LDEM, SOC-L WP, IND, MM</td>
<td>IND, MM</td>
<td>IND, MM</td>
<td>IND, MM</td>
<td>IND, MM</td>
</tr>
<tr>
<td></td>
<td>A, AT</td>
<td>A, AT</td>
<td>A, AT</td>
<td>A, AT</td>
<td>A, AT</td>
</tr>
<tr>
<td><strong>Instruct. Practices – Student-Focused</strong></td>
<td>SGW, DW, SP</td>
<td>SGW, DW, SP</td>
<td>SGW, DW, SP</td>
<td>SGW, DW, SP</td>
<td>SGW, DW, SP</td>
</tr>
<tr>
<td><strong>Notes:</strong></td>
<td></td>
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</tbody>
</table>

| **Student-Teacher Interactions Teacher-led** | IDQ, ICQ, IRQ | IDQ, ICQ, IRQ | IDQ, ICQ, IRQ | IDQ, ICQ, IRQ | IDQ, ICQ, IRQ |
|            | SQ, SR, PI | SQ, SR, PI | SQ, SR, PI | SQ, SR, PI | SQ, SR, PI |
| **Student-Teacher Interactions Student-led** | | | | | |

**Notes:**
### Pedagogical Strategies

<table>
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<tr>
<th></th>
<th>HUM</th>
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