ABSTRACT

CAYTON, EMILY MARTHA. Exploring Funding for Instructional Materials in Secondary Science Classrooms. (Under the direction of Dr. M. Gail Jones).

Science laboratory experiences are critical for students to develop an understanding of scientific inquiry and secondary school laboratories must have proper equipment and supplies available for students in order to conduct these experiences. Little is known about how decisions are made related to funding equipment and supplies and whether or not teachers have a voice in funding decisions for science materials and equipment.

This study examined the resources available for secondary science teachers to utilize in their classrooms, how decisions are made regarding funding for science instruction, and steps teachers take if they feel they do not have adequate funding for their classrooms. The study used a mixed methods design including quantitative data collected through an online survey and qualitative data collected through open-ended interview questions. The online survey revealed the amount of funding teachers received varied widely and was related to the location of the school. A sub-sample of the online survey participants (N = 24) volunteered to be interviewed about their experiences with funding for their science instruction. These participants were from regions across the United States and represented schools in urban, rural, and suburban areas. Teacher participants expressed concerns about insufficient funding as well as a lack of understanding of the funding process for their classrooms.

Exploring Funding for Instructional Materials in Secondary Science Classrooms

by
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DEDICATION

To my parents, Martha and John, my brother, Edward,

and the little people who call me Auntie Em.

To my grandparents.

To all teachers who go above and beyond for their students.

BIOGRAPHY

Emily Martha Cayton was born in Wilson, North Carolina in June of 1985. She attended East Carolina University on a full scholarship where she majored in Middle Grades Education. Following her graduation in 2007, Emily returned to Wilson County to begin her teaching career at Elm City Middle School. She taught 6th grade mathematics and science until 2011. Emily then returned to her alma mater, Beddingfield High School, to teach science. During her four years at Beddingfield, Emily continued her studies and earned her M.Ed. in science education at NC State University in December 2013. After one year of part-time enrollment in the science education PhD program at NC State, Emily enrolled full-time as a graduate student and found the learning experience to be incredible. She looks forward to her future in science education.

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CHAPTER 1: INTRODUCTION

There is a growing need for students of all backgrounds to pursue science careers to meet the demand for the 2.4 million new jobs in science, technology, engineering, and mathematics (STEM) careers through 2018 in the United States (Carnavale, Smith, & Melton, 2011). Holdren, Lander, and Varmus (2010) argue that STEM education needs to prepare a capable workforce to fill these job opportunities and to "strengthen our democracy by preparing citizens to make informed choices in an increasingly technological world" (p. v). Holdren et al. (2010) concluded that if we are to improve STEM education in the United States, all students must be proficient in STEM subjects and motivated to pursue STEM careers. Students who have adequate science laboratory resources and experiences may be more inclined to pursue science careers, as these activities may contribute to the development of science identities (Hazari, Sonnert, Sadler, & Shanahan, 2010).

Science courses and laboratory experiences require different types of funding, resources, and equipment than other courses, such as mathematics or social studies, and those resources and equipment can be expensive. In the United States there are variations in the distribution of school funding as individual states and school districts are not limited to a particular funding model. Additionally, sales, income, and property taxes vary among states and school districts. Odden and Picus (1992) reported "the major problem in school finance is the differential ability of school districts to gain equal access to property tax revenues." Additionally, a study by Rubenstein, Schwartz, Stiefel and Amor (2007) examining funding within large school districts found there is little scholarly research examining the procedures in which large districts allocate resources to individual schools.

With regard to science funding, Banilower et al. (2013) found that approximately 30 percent of schools reported inadequate funds for purchasing science and mathematics equipment and supplies, as well as a lack of facilities for teaching science (i.e. lab tables, faucets and sinks in classroom). The *Framework for K-12 Science Education* maintains that science courses should focus on inquiry and students should engage "in the (scientific) practices and not merely learn about them secondhand" (National Research Council [NRC], 2012, p. 30). Science laboratory experiences are critical for students to develop an understanding of scientific inquiry and high school laboratories in particular, must have proper equipment and supplies available (NRC, 1996). Understanding the funding needs of science courses, in particular, is imperative for stakeholders to ensure students are receiving an adequate education.

Adequately funding secondary science classrooms is paramount to ensure a meaningful science experience for students. Understanding teachers' experiences and perceptions of funding could lead to a more informed allocation of funds for science instructional materials by administrators and policymakers. It is their responsibility to maximize the utility of science classroom resources and make the best use of public funds to ensure student learning. Furthermore, if teachers understand how funding decisions for science instruction are made, they can better advocate for their departmental needs.

This study investigated how teachers receive classroom funding, who science teachers perceive as having the authority to make purchasing decisions, as well as determining what materials were purchased with instructional supply money. For this study, *instructional materials* or *instructional supplies* will include laboratory equipment, consumables for laboratory experiments such as chemicals, expendable materials, dissection materials, storage materials such as Ziploc bags, construction paper, and any other necessary materials for teaching and conducting laboratory activities and experiments in science classrooms.

Research Questions

The following research questions guided the design and analysis of this study:

RQ1: What is the relationship between the amount of money allocated for science instructional materials and school characteristics?

RQ2: Who do science teachers perceive as having decision-making authority in allocating funding for science instructional materials?

RQ3: How much money are teachers given to support science instruction?

RQ4: Do science teachers report having adequate funding for high quality science instruction?

Theoretical Frameworks

Educational funding is highly variable and influenced by local, state, and national policies. As a result, this study is situated in the frameworks of Bourdieu's theory of capital and Vygotsky's activity theory.

Bourdieu (1986) identified four forms of capital as *economic* (i.e., financial and economic resources); *symbolic* (i.e., social position); *cultural* (i.e., dispositions, cultural goods, and educational qualifications); and *social* (i.e., membership in a group). Utilizing Bourdieu's forms of capital, Archer, DeWitt, & Willis (2014) further theorized 'science capital' as science-related forms of cultural and social capital. While previous research has focused on students' science capital and their further participation in science (DeWitt, Archer, & Mau, 2016; Wilson-Lopez, Sias, Smithee, & Hasbun, 2018; Archer et al., 2015), this study explored the science capital of teachers as it relates to science funding.

The activity theory framework is relevant for this exploratory study as little is known about teachers' perceptions of funding for science instructional materials and each school, district, and state may have different mechanisms for funding science. This model considers all parties involved in the allocation of funding for science instructional materials as well as their fluid interactions. The framework allows for the examination of the interconnectedness of the pieces and subjects, not only by documenting their roles in the organization, but the rules that govern them. Activity theory evolved from the work of Lev Vygotsky and deconstructs the activity into components of *subject* (i.e., person being studied), *tool* (i.e., mediating device by which the action is executed), and *object* (i.e., the intended activity) (Hasan, 1998). Engestrom (2000) modified Vygotsky's original theory and added *rules*, the sets of conditions to help determine why individuals may act and *division of labor*, to provide for the distribution of actions and operations among a community of workers. This addition created a new plane called *community* by which teams of workers are anchored and can be analyzed **(**Hashim & Jones, 2007; Hyland, 1998**).** Figure 1 illustrates the relationship between these concepts (Engestrom, 2001).

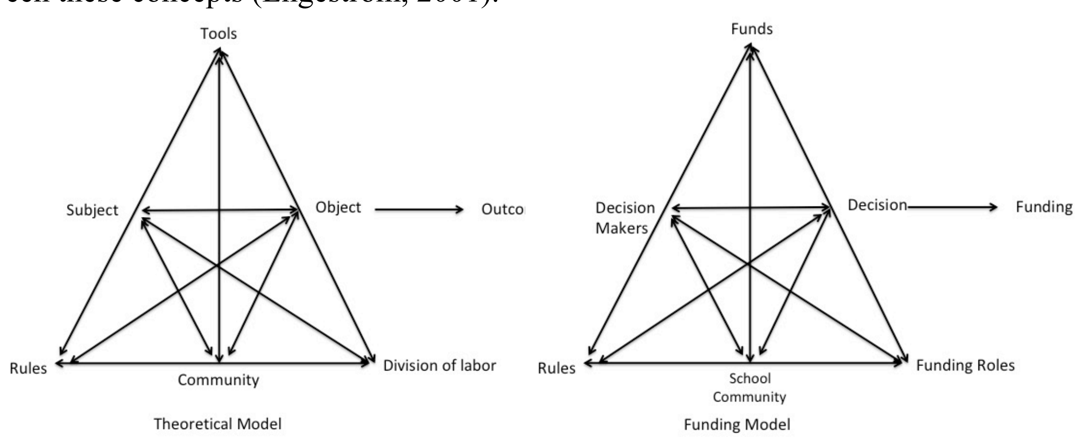

Figure 1. Activity Theory Models

When applying activity theory to educational funding for science, the individuals making decisions are the *subjects* and the *object* includes decisions being made about funding science instructional materials. The *tools* include the available funding for science instructional materials. The *community* encompasses the school district, and other supporting organizations (such as a parent-teacher-student organization) that the subjects are a part of and contains the *rules* used to govern or regulate educational funding. The *division of labor* defines how responsibilities are shared by the educators and policymakers as they engage in the activity of decision making about materials, in this case, the roles of the participants are the roles of science teachers, with some taking leadership positions. Leont'ev (1974) argued that participants in the activity are not fixed, but are fluid and can change as conditions change and as levels of engagement increase and decrease. Though this is a complex system, this study is a snapshot of the activity at a certain point in time.

Figure 2 shows possible factors that may result from adequate or inadequate funding for science instructional materials. There is research to show funding makes a difference with minority and disadvantaged students (Duncombe and Yinger, 2007; Rothstein, 2004) and there is indirect evidence that schools in high socioeconomic areas also tend to do more science laboratories and inquiry (Metty & Stuessy, 2007; Schenck & Meeks, 1999). What is not clear the steps teachers take when they lack adequate instructional material funding for science courses. There are reports that teachers spend significant amounts of out of pocket funds for instructional materials (Nagel, 2013). Many grants are available to science teachers but there is little research to document teachers perspectives on the adequacy of science funding and the impact of possible lack of funding on instruction, teacher planning, and morale.

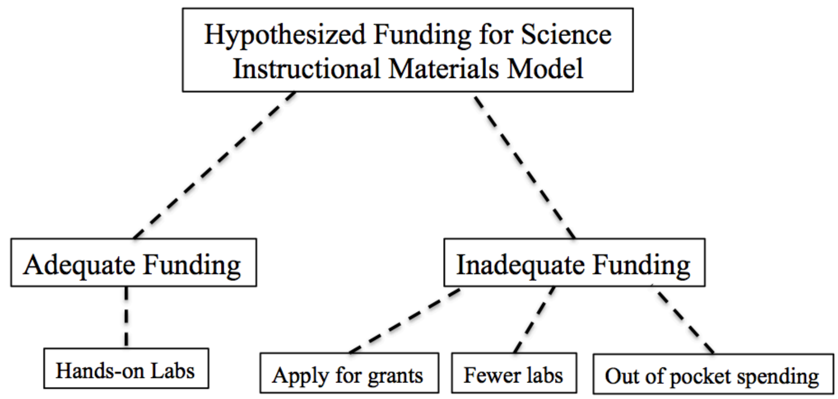

Figure 2. Hypothesized Funding Model

In the chapter that follows, the previous research related to school funding, science instruction, and funding for science materials are discussed.

CHAPTER 2: LITERATURE REVIEW

School Funding

Education is the largest expenditure for state and local governments and costs the public approximately $500 billion annually (Roza, 2010). The National Education Association (National Education Association [NEA], 2016) reported the average United States expenditure per pupil, for instruction for the 2014-15 school year was $11,709. This amount includes administration costs of the state board of education, state department of education, and county administration, including salaries and benefits for teachers (NEA, 2016). Per pupil expenditure also includes costs for instructional materials, transportation, building maintenance, and food service (NEA, 2016). Across the nation variation in available educational funds can be attributed to a difference in tax bases of various counties because school budgets rely on state income and sales tax (Biddle & Berliner, 2002; Lafortune, Rothestein, & Whitmore Schazenbach, 2016; North Carolina School Superintendents Association, 2016). For example, during the 2014-15 school year, per pupil spending ranged from $23,149 in Vermont to $7,461 in Arizona (NEA, 2016). The national average masks spending discrepancies as funding is localized and can be highly variable (Roza, 2010). New America (2017) reported that individual states and local governments provide approximately 44 percent each of all elementary and secondary education funding while the federal government contributes about 12 percent of all direct expenditures.

Though the sources of funds are the same (federal, state, and local), school districts and schools do not receive the same amount of money due to a wide range of implementation strategies. Baker, Sciarra, and Farrie (2015) described the three types of education funding systems as progressive, regressive, and flat funding systems. Baker et al. (2015) defined “a progressive finance system as allocating more funding to districts with high levels of student poverty, a regressive system allocates less to those districts, and a flat system allocates roughly the same amount of funding across districts with varying needs" (p. 2). Baker et al. (2017) found that 12 states had progressive funding systems, 21 states had regressive funding systems, and 15 had flat funding systems in 2012. This study excluded Hawaii and the District of Columbia because they are single-district systems, as well as Alaska due to inconsistent results (Baker et al., 2017).

Additionally, Roza and Hill (2006) studied several major urban school districts and found that spending among schools varies substantially within districts, and district leaders were unaware of where their money is being spent. District-level analyses may lead to inaccurate representation of spending and allocations may be underestimated (Condron & Roscigno, 2003). Researchers dug more deeply into funding by school districts to rectify the issue of data collection at a district level and, as a result, the *Journal of Education Finance* dedicated its Winter 1997 issue to the value of collecting school-level data to capture a more accurate snapshot of local funding (Condron & Roscigno, 2003). Collecting school-level data provides further insight as to how educational funds are spent but discretion must be used when making cross-state comparisons as there are differences in accounting and reporting standards (Picus, 1997). The present study examined teachers' perceptions and reports of their individual classroom expenditures to allow for the examination of the differences in funding across states and districts.

State legislation, when delegating financial responsibilities to local governments, can further cause discrepancies in funding for school districts. Local governments, utilizing property and sales taxes to supplement state funding, allow districts with property wealth the ability to generate adequate funding for their schools (Dayton & Dupre, 2004). Studies have shown that high-spending districts spend more money for instructional purposes and also taxed themselves at rates to support the increased expenditures (Hartman, 1999). Further, when local sales taxes are used to supplement funding, rural and urban residents are at a disadvantage due to active areas of commerce being in more suburban school districts (Dayton & Dupre, 2004). Challenges facing urban and rural schools are not limited to funding discrepancies. Research among urban schools found that these schools employ less qualified teachers than suburban schools (Lankford, Loeb, & Wyckoff, 2002). Additional studies suggest students living in rural areas face educational challenges such as a likelihood of attending poorly funded schools and a lack of quality facilities (Harmon, 2001; Seal & Harmon, 1995).

Funding and Achievement

While research on funding for science materials is limited, the research related to educational funding and student achievement is inconclusive. Some researchers have argued that an increase in educational funding does not necessarily correlate with higher student achievement on standardized tests (Nyhan & Alkadry, 1999). Hanushek's (1997) review of approximately 90 publications indicated an absence of a strong or consistent relationship between available resources and student performance (see also Hanushek 1986, 1989, 1991). Similarly, Wenglinsky (1998) did not find a relationship between mean school achievement and district expenditure (data were not collected at the school level). Conversely, Hedges, Greenwald, and Laine (1994), when reviewing many of the same studies as Hanushek, found that school resources actually matter. However, some studies argue that funding can be important when used with specific reforms (Murnane & Levy, 1996), or with minority and disadvantaged students (Duncombe and Yinger, 2007; Rothstein, 2004). Though there are differences in these findings, in order to understand a potential relationship between school achievement and expenditures, consistent and reliable data are needed (Wilson, 2000).

In a meta-analysis of journal articles reviewing studies of socioeconomic status (SES) and student achievement, Sirin (2005) found the relationship is stronger for students in suburban schools than for their rural and urban counterparts, reporting a significant difference for suburban and rural schools. Additionally, students in poor school districts have limited capital as compared to their peers in more affluent areas, leading to an achievement gap for these students. Students with low SES do not have comparable living circumstances to their peers in wealthier districts (Clune, 1994). These students also lack access to qualified teaching staff (Wenglinsky, 1998).

To better understand the extent of a relationship between student achievement in science and funding, clear definitions of student achievement are needed. Currently, individual states are able to define proficiency independently, directly impacting the number of students reaching proficiency in that particular state (Knoeppel, First, Della Salla, & Ordu, 2013). Further research is needed to determine if an increase in funding for science materials can help close the achievement gap for students in science courses.

Science Instruction

One goal of public education is to provide all students with an adequate education that qualifies graduates to become "citizens and competitors in the labor market" as determined by the New Jersey Supreme Court in 1976 (Abbott v. Burke II, 1990). Strong knowledge of science is an important 21st century skill for students if they are to be successful competitors in the labor market. Bybee (2010) noted that in order for citizens to be prepared to face the challenges of the 21st century, they must be STEM literate. Bybee (2010) also called for a broad, more coordinated effort in pre-college STEM education, as there is a growing need for students of all regions of the United States and backgrounds to pursue and persist in STEM degrees. The nationwide, 6-year degree completion rate for STEM majors is currently less than 40% with persistence in degree completion of underrepresented minorities and women in STEM majors being significantly lower than their peers (Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015). This discrepancy in degree completion has led to STEM career pipeline that is "leaky," resulting in students that intend to major in STEM subjects, but do not follow through with these intentions and leaving a void in the career workforce. Wang (2013) as well as Cromley, Perez, and Kaplan (2016) found some of the most influential factors in choosing a STEM major include exposure to math and science courses as well as self-efficacy beliefs.

A study by Banilower, Cohen, Pasley, and Weiss (2010) found the elements contributing to effective science instruction include motivation, eliciting students' prior knowledge, intellectual engagement with relevant phenomena, use of evidence to critique claims, and sense-making. Experts recommend providing laboratory activities to improve student motivation, engagement in high school science classes, and self-efficacy (Hofstein & Lunetta, 2004; National Center for Educational Studies, 2002). The National Science Teachers Association has recommended that high school teachers should spend 40% of science instruction conducting hands-on laboratory experiences (Stroud, Stallings & Korbusieski, 2007). However, simply conducting laboratory activities is not enough. *America's Lab Report* (NRC, 2006) discussed additional factors to influence the efficiency of laboratory experiences and the conditions to which they are likely to be effective. Their findings suggest that laboratory experiences should be designed with clear learning outcomes, designed to integrate science content with processes of science, and should encourage student reflection and discussion (NRC, 2006). Studies of undergraduate laboratory experiences have shown that labs often focus on detailed procedures, have limited opportunities for discussion and reflection, and lack the integration of science content and science processes (Hegarty-Hazel, 1990; Stutman, Schumuckler, Hilosky, Priestly & Priestly, 1996; Trumbull & Kerr, 1993; Windschitl, 2004).

Funding for Science Materials

Science requires different types of resources and equipment compared to courses in other disciplines and science resources and equipment can be expensive. A study conducted by the City of New York described conditions that inhibit mathematics and science initiatives, one of which was the condition of high school science laboratories and insufficient funds for materials and supplies (Schenck & Meeks, 1999). In a study focusing on mathematics and science instruction conducted by Banilower et al. (2013), inadequate funds for purchasing equipment and supplies was shown to be a serious problem by nearly 30% of schools and about 25% of schools reported lack of science facilities (i.e. lab tables, faucets, sinks). to be a serious problem. Effective science laboratory experiences are critical for students to develop an understanding of scientific inquiry and high school laboratories must have proper equipment and supplies available (National Research Council, 1996). The National Science Teachers Association (NSTA) provides a guide for planning school science facilities that explains laboratory design, equipment-needs planning, and safety research; however, it does not include an estimate of costs to stock the laboratory or classroom for science instruction (Motz, Biehle, & West, 2007).

Research has shown that there is a relationship between community income and spending on science consumable materials. Communities that serve large numbers of poor students tend to spend a third as much on consumables as communities who have few poor students (Metty & Stuessy, 2007; Schenck & Meeks, 1999). This discrepancy in funding is a social justice issue since low wealth communities are the very locations that could utilize the higher paying jobs that STEM careers provide.

Little research has been conducted to determine the cost of teaching various science courses. Advanced Placement courses offered by College Board, give students opportunities to take college-level courses while they are still enrolled in high school. College Board (2018) was created to provide access to higher education and prepare students for the transition from high school to college. These courses are designed for students to have a common curriculum and common lab experiences in order to successfully master the content. The College Board (2018) provides an estimate of the start-up costs for each of their science courses (Table 1) and the materials and equipment needed for teachers who teach these courses (Table 2).

Table 1

Cost to Implement Advanced Placement Science Courses

Course	Professional Development	Textbooks	Supplemental Reading	Materials and Equipment	Total
Biology	$400-$1,400	$3,000-$3,600	$500-$600	$5,050-$6,050	$8,950-$11,650
Chemistry	$400-$1,400	$2,500-$3,000	$500-$600	$4,500-$5,400	$7,900-$10,400
Environmental Science	$400-$1,400	$2,000-$2,400		$5,500-$6,600	$7,900-$10,400
Physics 1 and 2	$400-$1,400	$2,000-$2,400		$4,500-$5,400	$6,900-$9,200
Physics C: Electricity and Magnetism	$400-$1,400	$2,000-$2,400		$4,500-$5,400	$6,900-$9,200
Physics C: Mechanics	$400-$1,400	$2,000-$2,400		$4,500-$5,400	$6,900-$9,200

**Note.* Reprinted from *Consider the Costs,* by College Board, retrieved from https://apcentral.collegeboard.org/start-grow-ap/start-ap/begin-offering-courses/consider-costs

While the costs are only an estimate for implementation, the materials and equipment listed in Table 2 show a range of costs from $6,900 to $11,650 that are needed for students to complete required labs and experiences for these courses. This data suggests that biology, chemistry, and environmental science instruction require more expensive materials than physics. Table 2 shows a breakdown of costs for technology, such as probeware, followed by the cost for other equipment such as glassware, calculators, and spring scales.

Table 2

Materials and Equipment Needed for Advanced Placement Course Implementation

Course	Materials and Equipment
Biology	$3,500 for technology (includes resources such as probeware/sensors to collect data on cellular respiration/photosynthesis, osmosis/diffusion, transpiration, primary productivity, genetics of organisms and animal behavior, etc.) $1,500 for glassware and equipment (includes resources such as flasks, beakers, graduated cylinders, pipettes, Petri dishes, reagents and solutions, incubator, UV light, scales, living organisms, etc.) $50 for four-function calculators
Chemistry	$3,000 for technology (includes resources such as probeware/sensors to collect data on molar mass of volatile liquids, molar volume of gases, acid/base titrations, equilibrium constants, Beer's law, etc.) $1,500 for glassware and equipment (includes resources such as flasks, beakers, graduated cylinders, burettes, pipettes, reagents and solutions, hot plates, magnetic stirrers, Bunsen burners, etc.)
Environmental Science	$4,000 for technology (includes resources such as probeware/sensors to collect data on dissolved oxygen, nitrate, phosphate, conductivity, salinity, total suspended solids, pH, carbon dioxide, soil moisture and temperature, etc.) $1,500 for field equipment (includes resources such as kick-nets, seines, quadrats, line transects, air sampling devices, water and soil quality kits, and organisms for population studies, etc.)
Physics (1, 2 and C)	$3,000 for technology (includes resources such as probeware/sensors to collect data on motion, force, temperature, voltage and current, etc.) $1,500 for equipment (includes resources such as ballistic carts, spring scales, inclined planes, tuning forks, resonance tubes, mirrors, concave and convex lenses, prisms and magnets, etc.)

**Note.* Adapted from College Board, 2018, retrieved from https://apcentral.collegeboard.org/start-grow-ap/start-ap/begin-offering-courses/consider-costs

Materials and Instructional Decisions

There are many factors that impact teacher instructional decisions such as which materials to use, what questions to ask students, and what content is developmentally appropriate (Duschel & Wright, 1989). Teachers must also make instructional decisions based on their personal beliefs and motivation. For example, teachers' affective and evaluative components of belief, their feelings or mood, may affect the amount of energy a teacher will expend on classroom activities (Bryan & Atwater, 2002). Clough (2009) stated, "decisions regarding what science content to teach and tasks and materials that will help students make desired meaning are interrelated and should be made thoughtfully" (p. 826). Teacher instructional decisions based on their feelings or emotion could influence their motivation to conduct laboratory experiences in the classroom as well as their willingness to gather necessary materials in order to implement the activity.

Decision-Making Authority for Funding

Obtaining instructional materials for teaching science is a time-consuming and essential component in the daily work of science teachers. Because teachers lack, in most cases, direct access to funding, they must collaborate with their principal and other administrators. Previous research has shown that teacher empowerment is an important factor in teacher motivation. Lee and Nie (2014) found the immediate supervisors of teachers to be more likely than principals, to directly affect the psychological empowerment of teachers. Hirsch, Emerick, Church, and Fuller (2006) reported that when teachers are allowed to assist in decisions such as hiring and budgeting there is an impact on teacher motivation and empowerment. Transparency of administration when discussing funding and budgeting decisions for science instructional materials could increase teacher empowerment and autonomy. Additional research is needed to determine the effect of administrators' support of science teachers' participatory decision-making for classroom resources and instructional materials and the subsequent impact on student learning.

Out of Pocket Spending and Declining Funding for Science Materials

Funding for science instructional materials in physics courses has declined over time (Neuschatz, McFarling, & White, 2008). There is little information about how funding for science instruction has changed over time, but one study of physics instructors found that teachers had "less than half of the funds available to support the purchase of equipment and supplies than they did twenty years ago," after adjusting for inflation (Neuschatz, McFarling, & White, 2008). In a survey conducted by the National School Supply and Equipment Association (NSSEA), 99.5% of all public-school teachers reported spending their own money out of pocket. Teachers were found, on average, to spend $485 of their own money during the 2012-2013 school year (Nagel, 2013). Of the $485 average, teachers reported spending $149 on school supplies, $198 on instructional materials, and $138 on "other classroom supplies" (Nagel, 2013). Science teachers often need consumable materials for labs such as soil, seeds, plant materials, vinegar, and other household and grocery store materials. Theses consumables are often things needed quickly and may be items that do not store from one year to the next. Additional research is needed to assess the extent to which science teachers feel involved in funding decisions as well as how much money is spent out of pocket for laboratory consumable materials.

Science Teaching Capital

Archer, DeWitt, & Willis (2014) proposed the term of "science capital" to describe science-related forms of cultural and social capital as established by Bourdieu. Archer et al. (2015) noted science capital was unevenly spread across the student population they studied in England. In this study, the science capital of science teachers was explored in the context of funding for science instructional materials.

Bourdieu (1986) argued that capital presents itself in various forms: economic capital, cultural capital, and social capital. Bourdieu (1986) referred to economic capital as being immediately and directly convertible into money and the "root of all other types of capital" (p. 54). He further explained cultural capital exists in embodied, objectified, and institutional forms. Embodied capital is capital that is acquired over time and becomes part of a person, a habitus (Bourdieu, 1986). Bourdieu likened embodied capital to developing a suntan, unable to be immediately undone, or built over time. Embodied science capital includes knowledge of science principles, the ability to design experiments, as well as the ability to plan science lessons (Wilson-Lopez et al., 2018). Bourdieu (1986) labeled objectified capital as being in the form of cultural goods such as "pictures, books, dictionaries, instruments, machines, etc." (p. 47). Wilson-Lopez et al. (2018) argued "objectified capital is converted to embodied capital when youth acquire knowledge of scientific principles and applications through interactions with science-related objects" (p. 250). Objectified science capital would include teachers interacting with science related goods, such as science kits, and acquiring knowledge of using the science kits in their classrooms. The final form of cultural capital described by Bourdieu (1986) is institutional capital, which includes academic qualifications. Institutional science capital would be any degrees, certifications, or awards received by science teachers.

Social capital, as defined by Bourdieu (1986) is the compilation of actual or potential resources that result from being a member of a group. Some researchers (Appleton & Kindt, 2002; Colburn & Tillotson, 1998; Howes, 2002) found that new teachers needed to become part of the school community, while Scantlebury. Gallo-Fox, and Wassell (2008) found that a teacher's social capital impacts their power or agency. In a science context, Davis (2001) found participants in a Women in Science group were able to network and share grant writing information in order to obtain economic capital. This networking and exchange of information is imperative for teachers to obtain social science capital in order to obtain resources for their classrooms. Here social capital refers to teachers' participation in groups of teachers such as a science department or professional learning community.

Summary

The integration of laboratory activities comes at a greater expense to schools than a traditional, lecture-based science course. Adequately funding science courses allows teachers to conduct the recommended hands-on laboratory experiences. In addition, students as students are more likely to show gains when labs are integrated into the curriculum sequence (NRC, 2006).

CHAPTER 3: METHODOLOGY

This study used a mixed-methods design to collect quantitative and qualitative data from secondary science teachers in the United States to document their perceptions of funding for science materials, their understanding of the funding decisions, and their expenditures for science materials. Quantitative data were collected from middle and high school science teachers through an online survey to capture a broad snapshot of teachers' understanding and perceptions of funding for science materials in different states and regions across the United States. Qualitative data were collected from a subset of survey participants who volunteered to be interviewed (described further below). Research questions were developed using Vygotsky's activity theory (Engestrom, 2000; Hasan, 1998) to explore the interactions between various stakeholders involved with the funding process.

Research Questions

RQ1: What is the relationship between the amount of money allocated for science instructional materials and school characteristics?

RQ2: Who do science teachers perceive as having decision-making authority in allocating funding for science instructional materials?

RQ3: How much money are teachers given to support science instruction?

RQ4: Do science teachers report having adequate funding for high quality science instruction?

Institutional Review Board Approval

This study received approval from the North Carolina State University Institutional Review Board. Consent letters for the survey and interview participants informed participants that participation was voluntary and could be terminated at any time without penalty. Surveys were completed online and were anonymous. Participants who agreed to an interview submitted their contact information separately, as interviews were not anonymous. Pseudonyms for interview participants are used in the reporting of data.

Participants

Survey Participants

The survey participants (N = 738) consisted of secondary science teachers in the United States. Teachers were recruited through their state science teacher associations as well as state and national science teacher listserves to participate through a survey invitation e-mail (Appendix A) as well as social media (i.e., Facebook, Twitter). Survey participants were informed they would be entered into a drawing for one of ten, $25 Amazon gift cards upon completion of the survey.

The first contact was made by email to current presidents of the state science teacher organizations. Information was requested regarding the most effective way to make contact with secondary science teachers in their state (Appendix B). A personalized second email (Appendix C) was sent to organizations that did not respond to the first request for information. This email was sent to the current organization president, a past president, and webmaster or newsletter editor. It included an introduction of the study and a request for the survey invitation email (Appendix A) to be forwarded to secondary science teachers in their state.

Organizations were not able to share their email lists with the researcher due to privacy concerns, therefore the response rate cannot be determined for this study. Some teacher organizations distributed the survey to their entire mailing list, including elementary and informal educators, while other organizations included the link in their newsletters or posted the link to their website or on their public social media accounts. In these cases, there was no way to determine how many people read the invitation to participate in the study.

The demographics of survey participants are summarized in Tables 3, 4, and 5.

Table 3

Survey Participant Demographics for Gender and Ethnicity

		N	Study Sample Percent
Gender			
	Female	442	71.2
	Male	179	28.8
Ethnicity			
	African American	14	2.2
	American Indian or Alaskan Native	8	1.2
	Asian	10	1.6
	Hispanic or Latino	10	1.6
	Native Hawaiian or Pacific Islander	1	0.2
	White	564	90.0
	Other	20	3.2

Note. For gender, N = 621. For ethnicity, N = 627. These were optional items and participants chose not to answer both items.

As Table 3 shows, 71.2% of the teachers were female and 90% were white. These data are consistent with the findings from the 2012 National Survey of Science and Mathematics Education (Banilower et al., 2013) in which 70% of middle school science teachers and 54% of high school science teachers were female and 90% or more were white.

Table 4

Survey Participant Demographics for Course Type and School Location

		N	Study Sample Percent
Course Type	Middle School Science	134	18.1
	Life Science / Biology	212	28.7
	Chemistry	144	19.5
	Earth/Environmental	120	16.2
	Physics	129	17.5
School Location			
	Rural	259	35.0
	Suburban	279	37.7
	Urban	202	27.3

Note. N = 739.

Most of the survey participants taught life science (including biology) courses (28.7%), followed by chemistry (19.5%), middle school science (18.1%), physics (17.5%), and earth and environmental science (16.2%). The survey participants were more evenly distributed by school location with 37.7% from suburban schools, 35% from rural schools, and 27.3% from urban schools.

Table 5

Survey Participant Demographics for Years of Experience

	N	Study Sample Percent
Teaching Experience		
1-5 Years	100	16.1
6-10 Years	100	16.1
11-15 Years	141	22.7
16-20 Years	119	19.2
21+ Years	161	25.9

Note. N = 621

The survey participant15s reported a range of different levels of experience teaching, from 1 to 21 or more years. Most survey participants had 21+ years of experience (25.9%) followed by 11-15 years of experience (22.7%).

Participants were also classified by their geographic location (Table 6). The United States was divided using the 4 census-defined regions (US Census Bureau, 2012). The regions are as follows:

- *Northeast*: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont;
- *South*: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia;
- *Midwest*: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; and
- *West*: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table 6

Survey Participant Demographics for Region of United States

		N	Study Sample Percent
Region			
	Northeast	93	14.9
	South	234	37.7
	Midwest	180	29.0
	West	114	18.4

Note. N = 621

Interview Participants

A purposeful sample of survey participant volunteers, stratified by region and school location, were selected for the interview portion of the study (n = 24). The interviews provided in-depth responses from participants to examine survey responses in depth. The demographics of interview participants are summarized in Table 7.

Participants were chosen based on their region of the United States (described above) and the community in which their school was located (e.g. rural, suburban, urban). Of the six participants from each region, two were from each of the three teaching communities (i.e. two Northeast rural teachers, two Northeast suburban teachers, two Northeast urban teachers).

Table 7

Interview Participant Demographics for Gender, Ethnicity, and Years of Experience

		n	Interview Sample Percent
Gender			
	Female	17	70.9
	Male	7	29.1
Ethnicity			
	White	21	87.5
	Other	3	12.5
Teaching Experience			
	1-5 Years	5	20.8
	6-10 Years	3	12.5
	11-15 Years	8	33.3
	16-20 Years	2	8.3
	21+ Years	6	25.0

Note. N = 24

Instruments

The Funding and Instructional Materials in Science Classrooms Questionnaire.

The *Funding and Instructional Materials in Science Classrooms Questionnaire* (Appendix D) explored how much money is allocated for science instruction, teachers' perceptions of funding, and how decisions are made for purchasing science instructional materials. The 52-item questionnaire contained 27 selected response items and 22 open ended questions administered through Qualtrics (Qualtrics, Provo, UT) online software. Not all questions were displayed to every participant, as some questions were nested and only displayed based on the answer of the previous question. The questionnaire was created by a team of three science education researchers and was piloted with a group of 10 high school science teachers using Qualtrics software. The pilot study led to modifications, which included clarifying two questions and correcting the sequence of questions within the Qualtrics software.

The final questionnaire included these categories of questions: teacher and school demographics, amount and designation of funding for materials, decision-making, teachers' perceptions of funding, and sources of external funding.

Interview Protocol

An open-ended interview was used to explore teachers' perceptions of funding, sources of external funding, and processes by which their science department was funded. Teachers were interviewed using the *Teacher Funding for Science Instructional Materials Interview Protocol* (Appendix E). These questions were adapted from the initial funding survey completed by the participants and included 30 questions. The interview provided information about the teacher's demographics, school and science department characteristics, how the science department and individual teachers receive funding for instructional materials, perceptions of high quality science instruction, and steps teachers take if they do not have adequate funding.

All interviews were conducted by telephone due to the location of the participants. The interview consent form (Appendix F) was emailed to participants and all gave verbal consent prior to the interview. The interviews ranged from 25-45 minutes. The researcher took written notes during each interview. Interviews were also audio recorded and later transcribed.

Analyses of Survey Assessment

Data cleaning. After the survey data were collected (N = 794), they were downloaded from Qualtrics (Qualtrics, Provo, UT) as a SPSS file in order to clean and review. Participants were removed from the sample if they reported teaching elementary school (n = 30), only answered the first five demographic questions (n = 22), or reported teaching a subject other than science (n = 4). After completing these steps, there were 738 participants.

Significance testing. An analysis of variance (ANOVA) was used to determine if there were significant differences between the school location groups (rural, urban, and suburban) and the amount of funding reported by teachers for science instructional materials. A Chi-square test was conducted for perception of having sufficient funding for science instructional materials and school location.

Analysis of Open-ended Survey and Interview Questions. Open-ended survey questions, such as asking teachers to describe the steps they take to find external funding for science instructional materials and why teachers spend money out of pocket, were coded and analyzed for common themes and patterns using the constant comparative approach (Glaser, 1965). The coding themes are listed in Table 8. Two themes emerging from the interviews were control and need for funding. The inter-rater reliability was .86 for the two coders.

Table 8

Coding Themes

Code	Definition	Example
1. Funding	a. fully funded	Our school is very good at funding the science department.
	b. no funding	I have no funds.
	c. partially funded	I can do a reimbursement if I have receipts. But I also spend a lot of my own money.
2. Efficiency	a. need materials quickly	I needed the materials quickly.
	b. hard to be reimbursed	My county will not reimburse Amazon purchases
	c. easier than going through process	It is quicker to spend my own money than to go through the process of ordering things online sometimes.
3. Student Needs	a. need for student experiences	I want the students to get some lab activity experience
	b. best for student learning	I want what is best for my students no matter what it takes.
4. Teacher Effects	a. less stress	I would have less stress, therefore students would be more the center of my focus.
	b. time saving	It's just easier than all of the time grants take.
5. Hands on	a. inquiry	So the students can experience Science in the world around them and learn to be inquisitive and love science.
	b. student engagement	I want the students to be engaged in learning.
6. Equipment	a. smaller group sizes	Students would be able to work in smaller groups therefore, get more experience developing scientific skills.
	b. materials and technology	Lab activities could be done fully instead of being adjusted to meet the materials available.
7. Field Trips		We would have more opportunities to take field trips into our local community and do experiments.

Interview Analysis

The interview transcripts were read and themes were coded on the transcripts corresponding to the list in Table 8. For example, one participant responded:

> There are times when I'd like to do more demonstrations or when it would be great to do a full lab and not a demonstration. Rather than doing things as a demo, but as an inquiry based or problem based lab experiments and have students work through them. I currently do demonstrations because I don't have enough materials for all students.

This statement was coded for partial funding, student experiences, hands on, and equipment.

CHAPTER 4: RESULTS

The purpose of this study was to explore funding for instructional materials in secondary science classrooms. To understand the patterns of funding nationally and specific experiences, a questionnaire and interviews were used. The data are presented in this chapter and the results are described as they relate to the research questions. First, quantitative data analyses are presented to identify relationships between the amount of funding participants report and their location, type of course taught, and student socioeconomic status. Then, qualitative data are presented to provide context and details related to teachers' experiences.

Quantitative Findings

Research Question 1: What is the relationship between the amount of money allocated for science instructional materials and school characteristics? A one-way Welch analysis of variance (ANOVA), shown in Table 9, was used to determine if the amount of money allocated for science instructional materials was different in various school locations (i.e. urban, suburban, rural). Outliers were assessed by inspection of a boxplot, with 22 outliers greater than 3 box-lengths from the edge of the box and 27 outliers greater than 1.5 box-lengths. These data points were addressed by winsorizing, a process to modify the value to make it closer to the other sample values (Ghosh & Vogt, 2012). Using this winsorizing method, data points were adjusted to the next highest value that was not an outlier in order to maintain some of the information contained within the outlier, but making the data point less extreme. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance ($p = .00001$). The amount of allocated science funding was statistically different between school locations, Welch's $F(2, 39.434) = 451.533$, $p < .00001$. Games-Howell post hoc analysis revealed that the differences between categories of schools by location were all significant; urban and rural schools ($p < .00003$), urban and suburban ($p < .0005$) and rural and suburban schools ($p < .017$).

Table 9

One-way Welch ANOVA of the amount of money received for instructional materials by school location

	N	*M*($)	*SD*
Rural	249	462.93	546.36
Suburban	255	604.90	615.69
Urban	194	242.47	299.85
Total	698	453.52	538.58

Another one-way Welch ANOVA, shown in Table 10, was used to determine if the amount of money allocated for science instructional materials was different by the type of course taught (i.e. middle school science, life science/biology, chemistry, earth and environmental, physics). There were no outliers. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance ($p = .00001$). The amount of allocated funds was statistically different between different courses taught, Welch's $F(4, 37.814) = 315.040$, $p < .00007$. Games-Howell post hoc analyses revealed that there were significant differences between middle school science and all other types of courses ($p < .0005$). Significant differences were also observed between chemistry and earth and environmental science ($p < .015$).

Table 10

One-way Welch ANOVA of the amount of money received for instructional materials and course taught.

	N	*M*($)	*SD*
Middle School	124	160.20	187.50
Life Science	199	520.94	584.39
Chemistry	138	599.16	653.16
Earth/Environmental	113	385.50	403.65
Physics	124	538.55	553.02
Total	698	453.52	538.58

Research Question 2: Who do science teachers perceive as having decision-making authority in allocating funding for science instructional materials? This research question explored teachers' perceptions of the decision making process for science funding. As shown in Table 11, almost half of all participants indicated that their principal or assistant principal had decision-making power.

Table 11

Survey Data: Teachers' perceptions of decision-making power in allocating funds for science instructional materials.

	N	Percent of Total Responses
Principal/Assistant Principal	456	47.3
Science Department Head	175	18.1
Curriculum Supervisor/ District Representative	125	13
Teacher	63	6.5
Superintendent or Assistant Superintendent	42	4.4
Faculty Committee/ School Leadership Team	35	3.6
School or Advisory Board	30	3.1
Parent Teacher Organization	12	1.2
Other	7	0.7
Not Sure	20	2.1
Total	965	100

Note. Participants were able to select more than one option.

Of the participants who listed "other," two noted that their state department of education has decision-making power, four said there is no money for funding so no one is able to make a decision, and one noted teachers were able to ask for more funding by collecting more student fees.

In addition, teachers (N = 677) were asked if they felt they understood how funding decisions were made for instructional materials, and 62.5% reported they did not have an understanding. Teachers were then asked to explain how funding decisions are made at their school. Teachers who reported an understanding of funding decisions made comments such as, "Teachers request it and submit a rationale, then the principal and coordinator decide if they should purchase it or not" or "Our principal gives funds to those he likes, he doesn't like science or math." Some teachers indicated that funding was allocated evenly, for example, "It's (funding) based on pupil enrollment in science and divided up evenly between each of the science department teachers." Other participants indicated similar funds were distributed throughout departments within the school, for example, "The principal provides $3,000 to the English, math, science, PE, art, social studies, and world languages departments."

Of the teachers who reported *not* having an understanding (n = 423), 212 teachers made comments such as, "I'm not really sure," "administrational magic wand," or "not understood at all." Additional comments (n =100), indicated teachers had a partial understanding of the funding process. For example:

> I have no idea. We put in a requisition for items we need for the following year in February and they magically get ordered over the summer. Teachers are not part of the approval process, nor do they inform us if/when items get approved.

Other participants stated, “The principal has a budget, the science department is not consulted as to its needs,” and “We have varying amounts of funds to spend on science each school year, but we do not know that amount ahead of time. This makes it hard to plan long term spending.”

Table 12 investigates how likely teachers would be to seek funding from various stakeholders at the school, district, community, and state levels. Teachers were given a common list of stakeholders and were asked if they would seek funding from the individuals.

Table 12

Survey Data: Likelihood teachers seek out funding from various stakeholders

Stakeholder	Would ask without hesitation	Would ask but try another route first	Would ask only if I had to	Would not ask
Department Head	494 (74.3)	43 (6.5)	36 (5.4)	92 (13.8)
Principal	337 (50.7)	144 (21.7)	124 (18.6)	60 (9.0)
Assistant Principal	235 (35.3)	121 (18.2)	90 (13.5)	219 (32.9)
School District Administrator	107 (16.1)	137 (20.6)	156 (23.5)	265 (39.8)
Community Business Owner	77 (11.6)	148 (22.3)	184 (27.7)	256 (38.5)
School Board Member	40 (6.0)	56 (8.4)	140 (21.1)	429 (64.5)
County Commissioner	18 (2.7)	27 (4.1)	77 (11.6)	543 (81.7)
State Level Administrator	17 (2.6)	25 (3.8)	85 (12.8)	538 (80.9)

Note. N = 665

The results show that a majority of teachers (74.3%) would ask their department head without hesitation for instructional material funding, while half of the teachers (50.7%) indicated they would not hesitate to ask their principal.

Research Question 3: How much money are teachers given to support science instruction? In order to determine how much money teachers are given to support science instruction, teachers were asked about funding they directly received as well as funding received by the science department as a whole. Table 13 shows the amount of funding teachers received by school location and region. Teachers in suburban areas received 2.5 times more funds than teachers in urban areas and 1.3 times more funds than teachers in rural areas. Of the teachers reporting the amount of funding they received for their classrooms (N = 698), 24.6% of teachers (n = 172) reported receiving *no* money for science instructional materials and 35.8% (n = 250) reported receiving $100 or less. Table 13 also shows the amount of funding teachers received for science instructional materials by region. Teachers in the Northeast reported received 2.1 times more funds than their counterparts in the Western region of the United States and 1.7 times more than teachers reported in the South.

Table 13

Survey Data: Mean amount of money received for materials by location and region.

School Location	N	*M* ($)	*SD*
Rural	249	462.93	546.37
Suburban	255	604.90	615.69
Urban	194	242.47	299.86
Total	698	453.52	538.58
Region			
Northeast	93	686.38	630.99
South	232	393.78	497.30
Midwest	180	511.69	574.36
West	113	317.58	440.86
Total	618	458.22	544.80

Note. Outliers were removed from this table.

Table 14 shows the amount of funding teachers received by course type. Chemistry teachers received the most funding for instructional materials ($599.16) and middle school science teachers received the least amount ($160.20).

Table 14

Survey Data: Mean amount of money for classroom materials by course type

Course Type	N	*M* ($)	*SD*
Chemistry	138	599.16	653.16
Physics	124	538.55	553.02
Life Science	199	520.94	584.39
Earth/Environmental	113	385.50	403.65
Middle School	124	160.20	187.50
Total	698	453.52	538.58

Note. Outliers were removed from this table.

There was significant variation in the amount of funding different science departments received by location, according to participants. Suburban teachers reported their departments receiving the most money ($\bar{x}$ = $7634.39; SD = $8041.63) whereas rural departments reported receiving the least amount of money ($\bar{x}$ = $2700.89; SD = $4170.04).

Table 15

Survey Data: Mean amount of money science departments received for materials by location

School Location	N	*M*($)	*SD*
Rural	176	2700.89	4170.04
Suburban	189	7634.39	8041.63
Urban	120	3304.01	7597.90

Teachers were asked if the science department purchased items for all science teachers to use. Seventy-five percent of teachers (N = 739) reported the science department purchased items for all teachers to use. Table 16 indicates frequencies for various types of items teachers reported that were purchased by the science department.

Table 16

Survey Data: Frequencies for Types of Materials Purchased by Science Department

Type of Material	Frequency	Percent
Chemicals	488	66.0
Glassware	462	62.5
Hardware (Balances, Microscopes, etc.)	443	59.9
Safety Equipment	395	53.5
Dissection Materials	369	49.9
Lab Kits	348	47.1
Consumables (Straws, seeds, etc.)	338	45.7
Other Technology (Probes, etc.)	336	45.5
Office Supplies	295	39.9
Computers	27	3.7
Other Materials	17	2.3

Note. Teachers were able to choose multiple materials. N = 739

Chemicals were the item cited as being purchased most frequently by the science department for teachers, followed by glassware and hardware, while computers were the least cited item reported. Of the teachers who selected other materials, two commented "anything we request," three mentioned textbooks and magazines, three commented funds were used for live animals and aquarium maintenance, and one teacher each mentioned maintenance of equipment, demo materials, construction materials, models, online virtual labs, professional memberships, science project materials, and items from hardware stores.

Some teachers reported they were expected to purchase office supplies as part of their science instructional material funds (Table 17). Teachers reported purchasing items such as colored pencils, printer ink, glue, tape, and highlighters with their instructional funds.

Table 17

Survey Data: Expectations of teachers to use science instructional funds for office supplies by location

School Location		Frequency	Percent
Rural	Yes	107	43
	No	141	57
Suburban	Yes	114	45
	No	138	55
Urban	Yes	94	50
	No	94	50

Note. N = 688

Teachers were asked if they were ever denied funding when requesting materials or field trips. Table 18 shows the frequency of denied funding by school location.

Table 18

Survey Data: Teachers denied funding for new materials or field trips

School Location		Frequency	Percent
Rural	Yes	152	63
	No	91	37
Suburban	Yes	152	61
	No	96	39
Urban	Yes	126	68
	No	58	32

Note. N = 739

Over 60% of teachers in each location reported being denied funding for new materials or field trips. Teachers who reported being denied (n = 397) were asked how often and to give an example. Of the responses, 249 teachers indicated they were denied one to a few times per year, 84 indicated they were not turned down very often, 60 indicated they were turned down “every time” or “regularly.” In addition, 68 teachers reported they no longer ask for funds, for example “I don’t ask anymore unless I feel confident the funding will go through" and "I used to ask often for science funds and kept being told maybe but never received any funding. I stopped asking."

Teachers were also asked to report if some courses received more funding than others in their school. They were asked specifically about science courses receiving different funding, then broadly about courses across departments (Table 19).

Table 19

Survey Data: Reported differences in funding for science subjects and all departments

		Frequency	Percent
Science Courses			
	Yes	258	37.9
	No	257	37.7
	Unsure	166	24.4
All Departments			
	Yes	135	19.8
	No	322	47.2
	Unsure	223	32.7

Note. N = 681. Questions asked, "Do some science subjects receive more funding than other science subjects?" and "Do teachers of all subjects in your school (math, history, science, etc.) receive the same amount of money for instructional supplies?"

If teachers reported, "Yes, some science subjects receive more funding than other science subjects," teachers were directed to an open response box that asked which science subject received the most funding. Of the teachers who listed a response (n = 257), some teachers listed more than one subject. The subject responses are summarized in Table 20.

Table 20

Survey Data: Science subjects reported receiving the most funding

Subject	Frequency	Percent
Life Science	114	38.3
Chemistry	81	27.2
AP Courses	61	20.5
Physical Sciences	27	9.1
Earth Science	1	0.3
Other Science	14	4.7

Note. n = 298. Life sciences included anatomy, biology, forensics, and zoology while physical sciences included physics and robotics. The 'other science' category included courses described as STEM and career technical education courses (i.e., agriculture).

The open response box provided further responses that were not subject specific. For example, three participants reported their science funding was based on enrollment in the sections and three participants reported funding being based on fees assigned to particular courses. Additionally, four teachers reported that the courses taught by the department chairs received the most funding.

Research Question 4: Do science teachers report having adequate funding for high quality science instruction?

To explore teachers' perceptions of having adequate funding for high quality science instruction, frequencies for location and type of science course are outlined in Table 21 and 22 below. The majority of teachers from all school locations and all subjects report not having adequate funding for high quality science instruction for their students. In rural and urban areas, over 70% of science teachers reported inadequate funding, while 81.9% of middle school teachers reported inadequate funding for high quality science instruction.

Table 21

Survey Data: Teachers' perceptions of having adequate funding for high quality science instruction by location

School Location		Frequency	Percent
Rural	Yes	67	26.9
	No	182	73.0
	Total	249	100
Suburban	Yes	95	37.1
	No	161	62.9
	Total	256	100
Urban	Yes	42	21.9
	No	149	78.0
	Total	191	100

Table 22

Survey Data: Teachers' perceptions of having adequate funding for high quality science instruction by course

Type of Course		Frequency	Percent
Middle School	Yes	22	18.0
	No	100	81.9
	Total	122	
Life Science	Yes	57	28.9
	No	140	71.0
	Total	197	
Chemistry	Yes	51	36.6
	No	88	63.3
	Total	139	
Earth/Environmental	Yes	29	25.4
	No	85	74.6
	Total	114	
Physics	Yes	45	36.3
	No	79	63.7
	Total	124	

A chi-square test of independence was conducted for perception of having sufficient funding for science instructional materials and school location (Table 23). All expected cell frequencies were greater than five. There was a statistically significant association, $\chi^2(2) = 12.677$, $p < .002$. The association was small (Cohen, 1988), Cramer's V = .135.

Table 23

Results of Chi-square Test and Descriptive Statistics for Sufficient Funding by School Location

	School Location		
Report of Sufficient Funding	Rural	Suburban	Urban
Yes	67 (72%)	94 (47%)	42 (28%)
No	182 (28%)	161 (53%)	149 (72%)

Note. N = 695. $\chi^2 = 12.677$, df = 2, numbers in parentheses indicate column percentages, $p < .05$

To explore funding in science classrooms further, teachers were asked about the steps taken if they feel they do not have adequate funding to provide high quality instruction for their students. Eighty-three percent of participants reported changing their instructional activities due to a lack of funding for materials (N = 663), while 93% of teachers reported making, collecting, or soliciting donations for their classroom in order to teach labs (N = 659). Teachers were then asked if they sought out grant funding for their classrooms (N = 642) and 62% of these teachers reported submitting grant proposals. Of these submitted proposals, 78% were granted successfully, and teachers were able to use the funding for classroom materials.

Further, teachers were asked to report their out of pocket spending for science instructional materials. Table 24 shows teachers' out of pocket spending by course and school location. Urban teachers reported spending more out of pocket in middle school science, life science, earth/environmental, and physics courses than their rural and suburban peers. Rural teachers reported spending more out of pocket in chemistry courses than their urban and suburban peers. Over all geographic regions and course type, teachers spent a mean of $447.24 out of pocket.

Table 24

Survey Data: Teachers' out of pocket spending by type of course and location

		N	*M* ($)	*SD*
Middle School	Rural	42	441.90	399.75
	Suburban	37	405.41	308.17
	Urban	30	657.67	837.03
	All	109	488.90	540.01
Life Science	Rural	64	363.67	320.25
	Suburban	61	457.46	650.18
	Urban	44	446.48	530.91
	All	169	419.08	513.30
Chemistry	Rural	43	482.67	433.25
	Suburban	37	337.43	328.20
	Urban	33	438.48	576.03
	All	113	422.21	451.30
Earth/Environmental	Rural	30	479.10	493.99
	Suburban	40	478.00	432.53
	Urban	28	630.54	1054.69
	All	98	521.92	680.13
Physics	Rural	36	289.44	324.42
	Suburban	40	323.75	310.14
	Urban	24	711.67	1050.01
	Total	100	404.50	601.30
Total	Rural	215	406.43	391.07
	Suburban	215	406.79	456.12
	Urban	159	557.11	1093.54
	Total	589	447.24	679.09

Note. Mean represents dollars spent.

Teachers who reported spending money out of pocket for science instructional materials were asked why they chose to spend money out of pocket. These responses were coded into four categories: efficiency (i.e., needed items quickly, easier than following steps for reimbursement), student needs (i.e., needed materials for student experiences, student learning), no resources (i.e., no funds, have to spend money out of pocket or I don't receive materials) and other (not fitting into one of the other categories). Five hundred seventy-seven teachers chose to respond to the open-ended question and of these 186 teachers indicated spending out of pocket due to efficiency, 293 indicated spending out of pocket due to student need, 70 reported spending out of pocket due to no resources, and 18 were categorized as other.

Qualitative Findings

To better document participants' experiences and viewpoints on funding for science instructional materials, interviews were conducted with a subsample of survey participants. The results of the secondary science teachers' responses to the open-ended interview (Appendix E) follows. The questions were designed to gain a deeper understanding of data gathered from the survey. The summary is organized around four main themes: decision makers and the funding process, available funding and resources, steps teachers take as a result of insufficient funding, and funding related motivation and morale.

Decision Makers and Funding Process

Teachers were asked to report how their department is funded and who makes decisions with regards to science instructional material funding. Some participants were aware and able to describe more of the funding process than others. One teacher stated, "I know we get money, but I don't know what goes into the decision making process, I've been in this district for years and it's different at every school." Contrarily, another teacher who was more aware of the decision-making process reported receiving federal funds in addition to local funds. She discussed her district received federal grant funds in which each high school in the district received an extra $8,000, mandated only for science use. Of the other teachers interviewed, six described receiving money from the state level, nine reported receiving money from the district level, while eight reported receiving money from the school level.

When reporting on funding allotments, some teachers noted their school distributed funding by department and others reported funding was distributed to individual teachers. Of those teachers who reported their department receiving funding (n = 18), teachers described who made the decision as to how much each department received. One teacher noted that the state makes the decision, 11 teachers reported a school level administrator (i.e. principal, assistant principal, or dean) as the decision maker, four reported a district level administrator (i.e. science coordinator, school board), and two reported that they were unsure but thought the principal made the funding decision in cooperation with the superintendent. One interview participant explained, "Our principal sets our budget. He decides how much money to delegate. Last year we received $10,000 in order to start updating materials to more fully implement the *Next Generation Science Standards*." This teacher further explained this amount was unusually high and used to assist in the implementation of the newly adopted standards. Another teacher stated, "He (department leader) puts things (procedures) in place that make you not want to go ask him for stuff because you have to justify why you need it. I think the funds are there, but aren't available due to his choices."

Table 25 shows the participants' (n = 14) reports of how much money their department received, the origin of the funds (if available), and how funds were distributed to teachers. Of the remaining teachers (n = 10) who said their department was not allocated funding, one participant reported the school collected lab fees from each student, two participants reported no funds available for distribution, and seven participants reported that the administration distributes funds equally among teachers.

Table 25

Interview Data: Teachers' report of funds allotted and distributed by department

Participant	Department Funding	Funding Source	Distribution of Funds
N	$24,500	Principal	Teachers submit requests to department head by course taught.
D	$21,000	Principal	$5,000 on consumable supplies, $5000 on non-capital equipment, remaining allotted by course taught (i.e., chemistry classes received $2,300, biology classes received $1,700)
H	$15,000-20,000	Principal	Teachers submit requests to department head by course taught.
F	$10,000	Principal	Teachers submit individual requests to department head.
J	$7,000	Principal	Teachers submit requests to department head by course taught.
B	$5,000-6,000	Principal	Department created a formula based on number of students taught.
L	$1,200	Principal	Teachers submit requests to principal.
U	*	Principal	Department created a formula based on number of classes taught.
O	$4,000*	Administration	Teachers submit requests to administration team.
W	$19,000	District Administrator	Department created a formula based on number of classes taught.
Q	$6,000-7,000*	District Administrator	Teachers submit individual requests to department head.
I	$4,000	School Board	Supplies purchased as teachers need them.
T	*	Science Fees	Teachers submit individual requests to department head.
Z	*	State	All teachers receive equal amount.

Note. Participants with * indicated they were not aware how much funding was available for the department. Participant N's department funding includes $8,000 from a federal grant.

These funds were not always the only funds teachers reported. One Midwest suburban chemistry teacher stated, "Our assistant principal, at the end of the year, if there is extra money, she reaches out to chemistry because we tend to get hit the hardest with consumable chemicals." Additionally, one interview participant mentioned lab fees were charged to students at her school, however, not all students are financially able to pay the fee. The teacher reported:

> If you take my class and another class, you (students) only have to pay one lab fee, as they are not collected for both courses. I may have five that pay the $15 fee in a class of 15-20 students.

Available Funding and Resources

The 24 teachers interviewed were categorized based on their perception of having sufficient resources for their classroom. Of the 24 teachers interviewed, 12 participants reported having sufficient resources, six participants reported not having sufficient resources, and six participants reported being somewhere in between.

Of the 12 participants reporting sufficient resources, four were from urban locations, five were from suburban locations, and three were from rural locations. Participants were asked, "Do you think you have sufficient funding and resources to provide high quality instruction for your students?" Seven participants, when probed, stated they felt they had sufficient resources with no other explanation. One stated it was a condition of his moving to that school, "I'm not going to move without having what I need to teach." Another stated he felt he had sufficient resources now, as a result of collecting materials for 30 years. Additionally, another participant attributed his department funding to receiving grants from area businesses. Two teachers further described the freedom their department had to implement ideas at the last minute, with one stating, "I've never hurt for anything that I've needed" and the other recalled his department having an idea that required additional materials, and noted the availability of funds to order the materials online, receive them two days later, and conduct the activity in class.

Of the participants who reported *not* having sufficient resources, two were from urban locations, one was from a suburban location, and three were from rural locations. One teacher discussed her need to learn to write grants due to a lack of funding while another stated: it was her first year at the school, she was the only science teacher, and she was working with the resources available. Further, the remaining four teachers mentioned a lack of supplies and resources. One urban teacher in the South discussed the need to print 6-inch rulers for her students since physical rulers were not available. Another discussed that even if she was able to order materials, there was no space to safely conduct laboratory experiments. Another mentioned funding was only available for the first few months of school year and she hesitated to ask the principal for more funds. Additionally, another interview participant discussed science supplies being consumable:

> Even when you're talking about glassware, our supplies are consumable. I'm dealing with 15-16 year olds, stuff breaks - beakers and thermometers. It's not just the chemicals that get used up, but equipment has a shelf life and you have to replace it at some point.

Participants who reported being somewhere in between when asked if they had sufficient funding for high quality science instruction gave responses such as, "yes and no" or "sometimes." Of these respondents, two were from each location: urban, suburban, and rural. Of the two participants who stated "yes and no," these respondents made statements such as:

> I feel like I have a majority of my needs met, but not necessarily all. I usually spend $1000 out of pocket in a given year getting additional things. Once I've done activities (a few times) and had success with them, I am able to make an ask and sometimes get them (administration) to agree to use their discretionary funds.

Another stated, "Yes, I have what I need on a daily basis. Do I have the time and resources to extend beyond what I know, I would say no." Similarly, another teacher reported that she felt she had a majority of her needs met, but stated she usually spends about $1000 out of pocket for additional science instructional materials. A participant reported thinking that funds for science materials were probably allocated, however not available to her due to the department leaders' choices and policies. Another noted that without the extra funding that came with teaching an International Baccalaureate course, there would not be sufficient funding for high quality instruction in his other courses. Lastly, one teacher responded with "sometimes," citing she had a lot of equipment such as microscopes and some technology, but funds are not available for maintenance or replacement when they are broken.

One teacher mentioned her state required science instruction to be 50% hands on and further stated, "We do not have the funding to give students supplies to do that year after year, or replace equipment." Another teacher discussed the differences in the *Next Generation Science Standards* (NGSS Lead States, 2013b) and noted:

> We're not going to be able to cram with factoids at the last minute that we know are going to be assessed. They (students) will be assessed on doing science and unless they're doing that, students won't perform well on them or in college either.

Steps Teachers Take

Participants were first asked to report steps they take if they did not have sufficient funding, and then specifically if lessons were changed, if grants were applied for, or if funds were spent out of pocket. Five interview participants reported they have never been in a situation where there was a lack of funds or materials for science instruction and four participants noted they applied for local grants or utilized social media in order to gather necessary materials or funding. Three participants reported they would discuss the need with their supervisor, be it the department head or principal, and let the need be known. One interview participant who discussed enrolling in a Masters of Science Teaching program in order to leverage resources explained, “I’ve actually shown my lecture videos to my students so they can see things from a college professor.” Further, eleven participants described finding alternate assignments or bringing in materials from home.

When examining if lessons were changed due to a lack of funding, the participants were split evenly with 12 reporting yes and 12 reporting no. One participant reported no, but commented that if he wanted to do a classroom activity, he paid for it out of pocket and another reported that she has paid for the first few month of curriculum but had to change lessons for the remainder of the year. Of those who reported changing lessons due to a lack of supplies, three reported changing to online simulations, two reported altering lessons to use available chemicals, and one reported changing to a paper lab. One rural teacher explained, “Typically, I try to find alternate assignments, that’s why labs are paper based or they (students) create models. Sometimes I spend money out of pocket.” One participant changed lessons due to a classroom change in which she is now teaching in a science lab and another reported not having enough books for students. One interview participant who said she had access to the most basic supplies noted:

> I don't ask for things just because, I've spent time to plan out the process and procedure, and here is the list of things I need to make this a successful lesson or activity or to make my students more successful. We're not asking for the world, just for a little piece of it because we've spent the time to figure out what we need.

Nineteen of the 24 teachers reported they applied for grants to obtain funding for science instructional materials. Fifteen teachers reported they received the grants in which they applied, and three of these were awarded in previous school years, not the current reporting period. Four teachers reported their grant proposals were not awarded.

All teachers interviewed reported spending some funds out of pocket for classroom materials. Participants reported spending less than $50 per year to approximately $4,000 per year. Four participants reported spending less than $100 per year, 12 participants reported spending between $100 and $300 per year, four participants reported spending between $400 and $700 per year, and four participants reported spending over $1,000 per year out of pocket. One Western urban chemistry teacher who adapted to a lack of funds stated, "I spend money out of pocket and did less intricate labs with things I could do from the grocery store," while a Southern urban chemistry teacher reported:

> If I can afford it, I will go ahead and buy it myself. If I think it's important enough to jump through the hoops, I'll turn in the 50 pages of things I have to turn in to get the materials, or I'll just do the activity as a demo.

Motivation and Morale

Participants were asked if the amount of available resources or funding for science instructional materials affected their motivation or morale and responses were divided equally with 12 participants responding “yes or sometimes” and 12 participants responding “no.”

Five participants who responded their motivation and morale were affected by resources mentioned they were funded and lucky to have resources. One stated “I’m really motivated and excited when I’m able to do new activities and meet the needs of my kids.” Two participants mentioned stress on the work environment from teachers having limited resources and a feeling of having failed their students when limited resources made it impossible to facilitate certain classroom experiences. Frustration was mentioned by three participants who mentioned they were frustrated with the lack of resources available to them. One participant stated:

> How is it that based on somebody’s zip code that they have access to a significant amount of resources? It makes me mad at the general funding model that we have in this country, that we allow that type of inequality to exist.

Of the participants who responded that available resources did not affect their motivation and morale or funding for science instructional materials, six noted they understand that money is tight, that they were used to the situation, and they needed to be creative and willing to modify their lessons. One participant noted that “Teachers are expected to differentiate their lessons to accommodate students, but funding was not differentiated to accommodate teachers.” Two other participants described the number of tasks in the day and how teachers are treated when being informed of decisions within the school as being “morale killers.” While another teacher mentioned being the only science teacher in her school and the effect on her instructional planning. She stated:

> I haven't taught that many years, and I've never taught physics, so it's hard to plan ahead and know what equipment I need. I'm working as I go, so when I find equipment in the classroom, I go through them and see what's missing and order it. It takes a month for items to be delivered here.

Summary

Though these teachers have various experiences with funding in science classrooms, a Southern, rural physics teacher who received $100 for his instructional materials sums up their experiences. He explained,

> We are going to make it happen, we're not going to allow the fact that we don't have all of the nice lab equipment and resources available to affect the quality of instruction that we do. We take what we can get, we pull up our bootstraps and we make it happen and try not to let that be an excuse.

Limitations of the Study

Results of this study are limited to responses of participants who answered the questionnaire or participated in an interview. A possible limitation of this study is that participants were solicited through state science teacher organizations and not all teachers are members of these organizations. The degree to which non-members would have different perspectives is not known. All participants were volunteers and the data were self-reports. The degree to which information such as the amount of funding reported match the actual amount of funding received is not known.

CHAPTER 5: DISCUSSION AND CONCLUSION

In the sections that follow the results of the study are summarized and conclusions drawn from the data are presented. The discussion of the data, implications for action, and recommendations for further research are presented.

Summary of the Study

This exploratory study examined secondary teachers' experiences with and perceptions of instructional funding for their science classrooms. The study used a mixed methods design with quantitative data collected through an online survey and qualitative data collected through open-ended interviews. This study showed most secondary science teachers report having inadequate funding. The results of this study indicated that school (location) and the course type (domain) were significant in determining the amount of funding available for science instructional materials. Further, teachers were more likely to report principals or assistant principals as having funding decision-making authority. Finally, a majority of teachers reported inadequate funding for high quality science instruction.

Figure 3 shows factors related to funding for science instructional materials. Teachers who reported having adequate funding cited the ability to implement new ideas into their classroom as well as having inquiry-based instruction. Teachers who reported inadequate funding for science instructional materials discussed a lack of knowledge of funding decisions within the school or department, applying for grants, and having less inquiry-based instruction. These teachers also mentioned seeking out local resources from businesses or parents as well as spending money out of their pocket for science instructional materials.

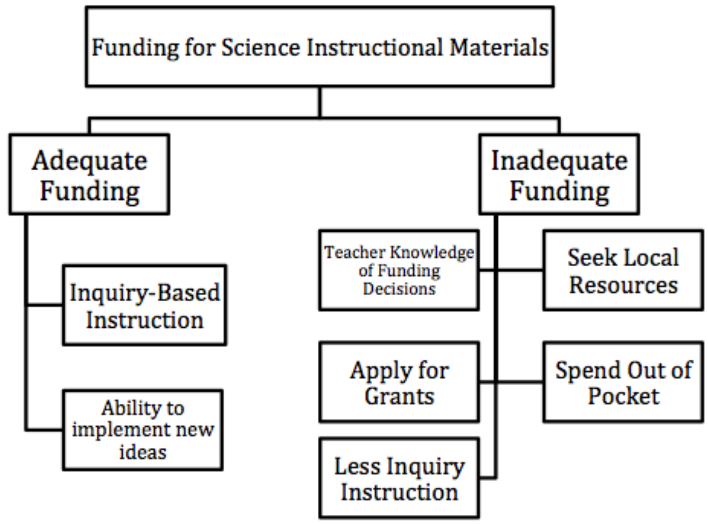

Figure 3. Funding for Science Instructional Materials Factors

Economic Science Capital

Some researchers have documented that there are disparities in educational spending due to variances in property wealth across districts (Brunner & Rueben, 2001; Moser & Rubenstein, 2002). Suburban schools in particular typically receive increased funding for education due to local property and sales taxes (Dayton & Dupre, 2004). The present study found secondary science teachers in suburban schools reported having 2.5 times more funding for science instructional materials than teachers in urban areas and 1.3 times more funding than rural areas (Table 13). One suburban interview participant in the Western region described funding for science instructional materials as almost exclusively a principal's decision. This year, his department received $5,000 to $6,000 for science instructional materials and 75% of those funds were distributed to teachers based on course enrollment. The remaining 25% of the funds were held in reserve by the department and there was an informal mini grant process. This participant received a base funding of $800 and through the mini grant process received $200 extra for a total of $1000 for science instructional materials last year. Contrast this with a teacher interviewed who taught in a Western urban school that reported funding as being a department leader decision. This participant reported receiving $250 in the last two years whereas five to six years ago teachers in their department received around $1000 for materials. Though these teachers are in the same region, they have vastly different funding. In this example, the activity theory triangle for the urban teacher is being stretched due to a recent reduction in departmental funds. This teacher is choosing to use out-of-pocket funds in order to finance her classroom as she cited district rules and policies governing the receipt of grant funds as a hindrance of applying for grants. There are many issues facing rural schools in addition to underfunding, including isolation and difficulty attracting highly qualified STEM teachers (Avery, 2013). Further impairing teacher success by underfunding science classrooms and implementing policies to discourage grant applications in these areas may make it difficult to recruit highly qualified teachers in these areas.

Disparities exist not only for teachers in different school locations, but also across the various science domains. There are clearly different needs for teaching science in the various domains. The initial cost of durable equipment for a new physics laboratory may be more than the initial cost of a new biology laboratory. However, biology teachers have a need for expendable materials such as cabbage, food coloring, fresh livers, and enzymes for laboratory experiments. For example, the survey data (Table 14) showed chemistry teachers received on average $599.16 for instructional materials with their interview participant colleagues reported receiving an average of $405. Earth and environmental science classes, once established may have minimal needs for expendables. Survey participants teaching earth and environmental science received on average $385.50. Interview participants teaching physics described a range from no funding to $800. Funding disparities across domains could impact students who want to pursue careers in these domains if there is a lack of resources available for these courses.

One of the questions of interest in this study was how much money teachers report being allotted to support science instruction. For individual classrooms, almost 25% of survey participants reported receiving *no* funding for science instructional materials. The mean amount of money for classroom materials (Table 13 and 14) shows there are large standard deviations for suburban school locations and chemistry courses, indicating that the values reported were highly variable across teachers and science departments. The interviews revealed that in one particular case, funds were collected using lab fees; with the teacher reporting not all students had the ability to pay lab fees. In another case, the teacher reported filling out a purchase order for necessary laboratory supplies in September that was yet to be approved in January. In these cases, teachers reported access to instructional materials, however, they had did not received materials for science instruction. In other cases where teachers reported having resources, they recognize the value in having economical capital and the procedural knowledge of how to obtain resources.

The lack of economic capital also manifests itself in the form of time. Teachers reported changing lessons, enrolling in Master's programs, writing grants, and collecting materials from local businesses in order to get resources or funds for their classroom. It is clear from these data that when inadequate funding exists, teachers spend large amounts of time writing grants, making, and borrowing materials. This expenditure of time has a significant impact on the quality of teachers' lessons, their morale, and their attitudes about their chosen profession. The time spent engaging in these activities could be redirected towards creating engaging, meaningful lessons for students if adequate economic capital was available to support teachers.

Further, teachers are spending money out of pocket for science instructional materials. As shown in Table 24, the average out of pocket expenses for all survey participants was $447.24. Urban teachers were found to spend more out of pocket than their suburban counterparts in all subjects except life science. Science teachers are not only making pedagogical choices based on resources available (i.e., using paper labs instead of hands-on activities) but making personal choices as well, in order to finance what they feel are best practices for teaching science.

Embodied Science Capital

Bourdieu (1986) defined habitus as “external wealth converted into an integral part of the person” (p. 48). This embodiment of science teacher capital is important because it includes the knowledge, skills, and behaviors needed to understand and navigate the funding process for science instructional materials, and strategies for obtaining funding. In this study, 423 (62.5%) teachers (N = 677) reported they did *not* have an understanding of how funding decisions were made for instructional materials. Though teachers reporting *not* having an understanding, 312 participants described the process of how science instructional funding decisions were made at their school, in which 100 teachers indicated they actually had a partial understanding. The lack of consistency and the ambiguity with which funding decisions are made affects teacher’s instructional planning for science. For example, because laboratory experiments must be planned ahead of time in order to obtain proper materials for student success, many teachers reported long lag times between requests for and accessibility of funds or instructional materials. The possibility exists for teachers being unaware of whom to reach out to in order to advocate for funding for instructional materials.

Interview participants noted that their schools received a certain amount of funding from the district, but participants were unable to determine how the principal (or designee) made decisions regarding funding for science materials in particular. Participants noted the principal received a budget and at his or her discretion divided it among departments or individual teachers. No participants were able to explain how decision-making authorities (i.e., principal, district science coordinator) determined a funding amount for science instructional materials. In these examples, the interview participants were not aware of the roles of stakeholders or rules governing the distribution of funds. This process knowledge is imperative in order for teachers to develop strategies to obtain funding. This research suggests that teachers should be made aware of how decisions are made for allocating funds to their classrooms. Teachers could serve as a vital resource in the decision-making process, being aware of which classrooms are in need of funding for specific materials.

Objectified Science Capital

The participants reported chemicals, glassware, and hardware as being materials most likely being purchased by their science department for use in all science classrooms. In order for teachers to convert these objectified science capital materials into embodied capital, teachers need experiences and interactions with these science-related objects. A common theme throughout the interviews was object permanence. Science is a discipline that often utilizes consumable, or one-time use materials for laboratory experiments, such as brine shrimp, plants, strawberries for DNA extraction, and chemicals. The cost of supplying science laboratories is a continual budget item for administration to consider when funding science departments.

Not only are science teachers purchasing materials to be used directly for science instruction, there also seems to be an expectation to use science funding for common office supplies from school budgets. Almost half, 45.7%, of all survey participants reported they were expected to purchase items such as tape, colored pencils, glue, and highlighters with their instructional funds (Table 17). One interview participant stated she received three packs of paper at the beginning of the year for her classroom with any additional needs for paper being purchased at her expense. Participants noted a change in pedagogy due to a lack of funding for materials in that many activities were conducted using paper versions of activities that might otherwise be done with hands-on materials because schools did not have resources such as microscopes for students to use. This is yet another reason why teachers should be included in the decision-making process for funding for science instructional materials.

Interview participants discussed a transition from their current curriculum to the *Next Generation Science Standards* (NGSS Lead States, 2013b), and the need for additional materials in order for students to conduct laboratory experiments and manipulate variables when collecting data. Performance expectations are incorporated into NGSS and for high school physics include “developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematical and computational thinking and constructing explanations” (NGSS Lead States, 2013a). A lack of objectified capital could cause tremendous obstacles for these teachers, such as the economic burdens of purchasing materials out of pocket, if these standards are implemented in their states. NGSS are being adopted at the state level and if teachers are to be successful, policymakers will need a better understanding of the materials teachers need for science instruction and how they are used.

Institutional Capital

Bourdieu (1986) discussed institutional capital such as academic achievements or leadership titles bestowed on a person. In this study, teachers overwhelmingly attributed decision-making authority first to a principal or an assistant principal and second to a science department head (Table 11). But when asked the likelihood teachers would seek out funding from various individuals, 50.7% reported they would ask their principals without hesitation, whereas 74.3% of teachers reported they would ask a department head without hesitation. This variation could be due to the chain of command in which a department head would advocate for funding on behalf of the department rather than individual teachers advocating to the principal.

The institutional capital associated with the authority of science department head cannot go without acknowledgement. When teachers were asked which science courses received the most funding, four teachers (n = 298) reported their department head's courses received the most funding. This was further explored in participant interviews. One teacher mentioned that she was not the department head; it was based on seniority and the teacher currently in that position was a 25-year veteran. Another discussed the lack of transparency with her department leader in that he made it difficult to acquire materials. However, not all teachers had problems with the department head controlling funding in inequitable ways. Almost half of the participants (45.8%) mentioned their department heads requested lists and purchased supplies for the department in the most democratic, amicable way possible.

Social Science Capital

Social capital has been shown to be a factor in accomplishing goals (Davis, 2001). In this educational context, social science capital can help teachers influence the decision-makers in order to obtain increased funding for science instructional materials. When teachers were asked if they were likely to seek out funding from individuals at the county or state level, over 80% of participants responded they would not ask. A majority of teachers surveyed indicated they would not ask community business owners or school board members for funding or resources. However, four interview participants mentioned the importance of their community businesses in that they provided grants, donations, and being involved in the schools. Creating a network of connections with individuals with decision-making power, knowledge of funding, or economic capital could prove to be beneficial for teachers who solicit science instructional materials from their community.

The social capital of science peers could benefit science teachers when obtaining resources for science instructional materials and understanding the funding process for materials. In the present study, 3% of participants indicated being unsure of who has authority to make funding decisions and 62.5% of survey participants reported not understanding how funding decisions were made. Having access to a mentor or peer teacher in order to navigate the funding process could be extremely valuable. Davis (2001) documented the exchange of ideas and information regarding grant writing in her study. In this study, one interview participant described her teaching role transitioning into a coach role, where part of her job is advising new teachers with strategies throughout the grant writing process. Providing strategies for obtaining instructional materials would also provide invaluable peer capital for new teachers. One participant in the present study described her teaching situation as being located in a very rural part of the United States, where she is the *only* science teacher. She reported having some materials available, however, she is teaching many different science courses at once. This teacher has no peers and faces greater challenges in figuring out the best way to access resources, in addition to figuring out the resources she will need to teach the various science domains. The lack of peer capital influences the entire funding system for this teacher and leaves her at a disadvantage, as she is not aware of the decision-makers, the rules, or the tools available to her. Teacher knowledge of materials to teach science, knowledge of how to obtain equipment and materials, and time are critical to obtaining needed materials to teach science.

Science Teaching Capital

The various forms of capital, economic, social, and cultural, are all pillars and encompass science-teaching capital. Figure 4 shows the science-teaching capital model.

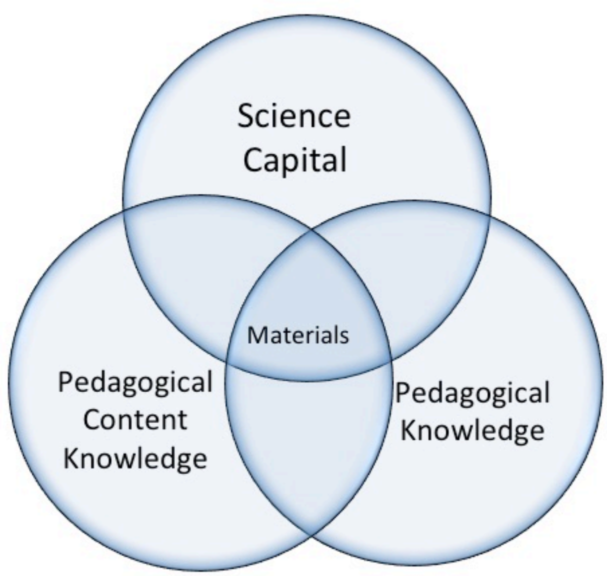

Figure 4. Science Teaching Capital Model

Research has shown that teachers need a range of different types of knowledge and skills to be successful. Grossman and Richert (1988) defined teacher knowledge as, “a body of professional knowledge that encompasses both knowledge of general pedagogical principles and skills and knowledge of the subject matter to be taught" (p.54). For example, a science teacher needs to have science content knowledge (Berry, Friedrichsen, & Loughran, 2015), pedagogical knowledge (Shulman, 1986; Tamir, 1991), and science capital (Archer et al., 2015). Science content knowledge includes knowledge of the domain and the laboratory skills that are part of that domain. Pedagogical content knowledge includes knowledge of how to teach the science domain and includes knowledge of specialized equipment and materials that would be used to teach specific science concepts. Science capital defines the experiences, networks, and access to information and materials needed to teach science. Increased funding influences teachers' science teaching capital. An increase in science capital for teachers influences the degree to which they are able to build science capital in their students.

Having an understanding of what resources are needed for instruction and how these resources are obtained are a large part of a science teachers' required knowledge that overlaps pedagogical and pedagogical content knowledge. A lack of resources or knowledge of how to obtain resources *could* have a detrimental impact on science instruction.

Implications

The inequity in funding for students in rural and urban areas is ultimately a social justice issue. The results showed a suburban teacher from a wealthier community could receive about $600 for materials whereas another teacher from a rural area might get no funds. This translates into a huge disparity in the types and quality of laboratory experiences that students have as part of their science instruction.

Teachers also reported modifying instruction or eliminating some lessons, due to a lack of materials or funds for instructional materials. Consider a typical science teacher at a rural high school in the Southern United States. She teaches biology for three, 90-minute periods per day and has 25 students in each class. There are no textbooks but students all have devices (i.e. tablets). The teacher would like for her students to have experiences with extracting DNA from strawberries, running a gel electrophoresis lab, completing a photosynthesis and cellular respiration lab, and conducting a frog dissection. The teacher is given one box of paper for the year, and budget of $100 for all materials needed throughout the year. How many hands-on, student centered, inquiry labs will she be able to conduct? How many students will have to share the dissection of a small frog that costs $13.95? If this teacher bought a frog for every 2 of the 75 students she teaches, the frogs alone would require $523 – far more than her $100 budget provided for all the labs over the entire year. Moreover, how many nights, weekends, and planning periods will she spend being creative in gathering, making, and borrowing resources so her students have an adequate understanding of biology? From a policy perspective, if professional science teacher organizations made recommendations for laboratory activities to conduct as well as funding, teachers could collaborate with funding decision-makers to obtain adequate funding for these critical instructional materials.

This study revealed most teachers report they do not have funding for high quality science instruction. The participant interviews further revealed that teachers want to be creative in their choices for their classroom experiences, their classrooms to be more student-centered, and to allow students to deviate from prescribed laboratory experiences, but access to materials and resources are significant limiting factors.

There are discrepancies in funding among the various types of science courses taught. Each discipline has unique tools, for example the need for titration equipment for chemistry or a stream table for earth science, all of which require different levels of funding. When teachers "make do" with homemade or poorly functioning materials, they introduce safety hazards into what might otherwise be a safe lesson. For example, using salvaged specimens for dissection could result in students being exposed to harmful bacteria. Science materials have shelf lives and are not permanent. Schools and teachers need realistic and reasonable plans to obtain, maintain, and replace equipment and materials.

The findings from this study suggest the following recommendations:

- Make the process of funding science instructional materials transparent so teachers and other stakeholders understand how instructional materials are funded.
- Teachers need knowledge of the decision making process for funding materials and who to contact if they are in need of funding for instructional materials.
- Teachers could benefit from professional development with other teachers to develop resources and strategies to teach science with limited or no materials.
- Communication is needed so policymakers, school board members, and other stakeholders better understand the cost of science instruction and the continual need for science instructional materials. This includes the costs of expendable materials as well as long-term maintenance of lab equipment.

- Increased collaboration with business and industry professionals to develop plans for obtaining needed materials (and donations) could alleviate funding deficits for science instructional materials.

Future Research

Science education research has not clearly documented which laboratory experiences are most effective. Aside from AP courses, it is not clear if there are fundamental labs that all science teachers should conduct in the various domains. Having this knowledge could help policymakers predict and budget for ongoing funding for both equipment and consumable materials needed for science instruction. As technologies advance and become available, future research is needed to examine which labs can effectively moved to a virtual environment without losing effectiveness. It is also not clear how frequently teachers want to innovate and design new lessons, as this should also be incorporated into funding decisions. More research is needed on how administrators make budget decisions when faced with requests from all subject areas within a school. Future research could investigate the availability of science funding and science achievement. On a global scale, future research could include how science instructional materials are funded in various countries.

Conclusion

This study argues for an overhaul of the processes and economic capital available for science teachers. Research has not addressed science funding within the larger system of school finance. This study is a unique contribution as it aims to understand the relationship and determine how science teachers fit within the broad system of funding, implications for student learning as well as teacher motivation.

As the demands for instructional accountability continue to increase, science teachers must be given access to the knowledge and resources to purchase the materials needed to ensure high quality science instruction for all students. A need exists for transparency in the decision-making process for funding science instructional materials. Understanding the funding process and how to leverage resources is crucial for science teachers to obtain materials needed for their classroom. Teachers should feel comfortable asking questions without fear of repercussions instead of remaining complacent with spending money out of pocket or doing without materials. We currently do not know the full impact of inadequate funding on teacher retention, teacher morale, or student learning.

In conclusion, this study shows that for the vast majority of science teachers who participated in this study, funding is woefully inadequate. It is particularly appalling that almost 25% of participants report having no funding for science instructional materials and 62.5% of participants reported lacking the knowledge of how funding decisions are made. Considering the national goals of increasing the quality of STEM education, increasing student interest in STEM, and dramatically increasing domestic youth entering the STEM workforce, change is imperative. It is paramount that communities, policymakers, and educators create procedures where teachers have access to materials and equipment, have knowledge of funding processes, as well as the power and authority to design and create innovative lessons. The end result if we do not heed this call for change is to continue a downward spiral where teachers become frustrated and leave the profession and our students decline in achievement and competitiveness on a global scale.

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APPENDICES

Appendix A: Invitation Email

Help inform funding for science education

As seen in recent news reports, teachers are spending out of pocket money to support their classrooms. Science teachers conducting lab activities often need more resources than other classroom teachers. Little is known about the extent to which science teachers search for resources for science materials or adapt their teaching due to the ability of resources.

Please consider taking this 10-minute online questionnaire to give your perspective on funding and resources in high school science classrooms. Participants will be eligible to be entered in a drawing for a $50 gift certificate to Amazon (or similar vendor) for completing the questionnaire.

Link to be inserted here

Appendix B: Initial Email to State Organizations

Hello!

I am a Science Education PhD student at North Carolina State University. My dissertation is focusing on funding for instructional materials in high school science classrooms and data will be collected through an online survey.

I am wondering if you could give me information regarding the best way to contact high school science teachers in your state.

Thank you in advance for any help you can provide!

Best,

Emily Cayton

Appendix C: Follow Up State Organization Email

Hello,

I am a Science Education PhD student at North Carolina State University. My dissertation is focusing on funding for instructional materials in high school science classrooms and data will be collected through an online survey.

I was wondering if you could forward the information below to high school teachers in *state name inserted here*. I am trying to collect data from all states. My goal is to have representation nationwide and be able to share any data I collect back with the state science teacher organizations.

Thank you for any assistance you can provide!

Emily Cayton

Colleagues,

Help inform funding for science education

As seen in recent news reports, teachers are spending out of pocket money to support their classrooms. Science teachers conducting lab activities often need more resources than other classroom teachers. Little is known about the extent to which science teachers search for resources for science materials or adapt their teaching due to the ability of resources.

Please consider taking this 10-minute online questionnaire to give your perspective on funding and resources in high school science classrooms. Participants will be eligible to be entered in a drawing for a $50 gift certificate to Amazon (or similar vendor) for completing the questionnaire.

Use the link below to complete the survey. Please forward to colleagues who may be interested in sharing their experiences.

Link to be inserted

If you have any questions, please contact emcayton@ncsu.edu

Appendix D: Teacher Funding for Science Instructional Materials Questionnaire

You are invited to participate in this voluntary questionnaire of science instructional materials funding and spending in high schools. As part of my graduate training, I am exploring how much money is allocated and how decisions are made for purchasing science instructional materials.

There is some evidence that teachers across the state and nation may receive very different amounts of money and procedures for deciding how money is spent may vary widely. In the sections that follow, you will be asked a series of questions that will allow me to look across different types of schools and science subjects to better understand science instructional spending. Please be honest in your responses. Your responses will be anonymous (no one will know who filled out the survey).

1. What is your gender:
    a. Male, Female
2. What is your ethnicity:
    a. Caucasian, African-American, Hispanic, Asian, Other
3. Please indicate your highest level of education:
    a. Bachelor's Degree, Master's Degree, Doctoral Degree (PhD. Or EdD)
4. How many years have you been a teacher?
    a. 1^{st} Year, 2-5 years, 6-10 years, 11-15 years, 15 – 20 years, 20+ years
5. How many years have you been in your current position?
    a. 1^{st} Year, 2-5 years, 6-10 years, 11-15 years, 15 – 20 Years, 20+ years
6. Please check all that describe your current school:
    a. Public, Private, Public Charter, Parochial / Religious, Magnet, Early College, STEM, IB School, Title 1, Middle College
7. Is your school classified as?
    a. Rural, Urban, Suburban
8. Which state are you located: Dropdown list of states
    a. If NC: Dropdown list of counties
9. How many science teachers does your school employ (including yourself)? Open
10. How many science classes do you teach a day? Open
11. How much money was allocated to the science department for science instructional supplies during the 2016-17 school year? Open
12. Does the science department purchase items for all science teachers to use?
    a. If yes: Click the following categories in which the department makes purchases: Dissection Materials, Chemicals, Glassware, Office Supplies, Computers (Do not include computer purchases made with other funds), Safety Equipment, Hardware (Balances, etc.) Lab Kits, Other Technology (Probes, Labware) Other: Please list.
13. How much money did you receive for science instructional materials in your classroom during the 2016-17 school year? Open
    a. The amount listed above will be used to reach how many students?

14. Is there an expectation that you use your science instructional materials funds to buy common office supplies, or school supplies such as dry erase markers or staplers?
    a. If yes, please explain what other supplies are expected to be purchased and how much of the amount listed above was used to purchase office supplies such as colored pencils, paper, tape, scissors, etc.)?
15. Do some science subjects receive more funding than others?
    a. If yes, list which subjects receive more.
16. Do teachers of all subjects (math, science, history, etc.) in your school receive the same amount of money for instructional supplies?
17. Who makes the decision about how much money you have to spend on science supplies? We are not as interested in the chain of approval, but interested in who has decision making power:
    a. Check box: Science Dept Head, Curriculum Supervisor, Principal, Teacher, PTA, School Improvement Team, Other (Please describe).
18. Do you ever find it overwhelming to try to obtain funding to purchase supplies for labs?
    a. If Yes, please explain.
19. Have you ever tried to obtain funding for materials for a new lab or field trip and then gave up when you were turned down? How often?
    a. Please explain.
20. If you had to ask for funding from the following types of leaders (no one specific)--rate how you feel about asking.
    a. 0 Would not ask, 1 Would ask only if I had to, 2 Would ask but would try another route first, 3 Would ask without hesitation
    b. Department head (teacher leader), Assistant principal, Principal, School district administrator, School board member, County commissioner, Administrator at the State Level, Community Business person
21. Have you ever changed your instructional activity due to a lack of funding for instructional materials?
    a. If yes, please explain and give an example.
22. Do you make, collect your own materials, or solicit donations to teach labs?
    a. If yes, please give an example.
23. Think about a typical course, how many different labs a year would you estimate that you make or collect your own materials? Open
24. Have you ever submitted a proposal for a grant for science instructional materials:
    a. If yes, did you receive funding for your proposal?
    b. If yes, how much funding did you receive and what materials did you purchase with the grant?
    c. If yes, how many grants have you received in the last 3 years?
25. Do you spend money out of your own pocket for science instructional materials?
    a. If yes, estimate the total amount you spend out of pocket per year.
    b. If yes, why do you choose to spend your own funds on science instructional materials?
26. Which types of items do you purchase with out of pocket money?
    a. Check boxes: Dissection Materials, Chemicals, Glassware, Office Supplies, Computers (Do not include computer purchases made with other funds),

Safety Equipment, Hardware (Balances, etc.) Lab Kits, Other Technology (Probes, Labware) Other: Please list.

27. Please check all of the following methods that you have used for obtaining materials or funding for your classroom:
    a. Check boxes: Parents, DonorsChoose.org, GoFundMe, Kickstarter, Local Companies, Lab Donations, Contacting Manufacturer, PTA
28. Do you think you have sufficient funding for science instructional materials to provide high quality instruction for your students? Please explain. (Open)
29. Do you feel that you understand how funding decisions are made at all levels?
    a. Checkbox: Federal, State, Local
30. In the space below, is there any additional information you would like to provide describing science instructional material funding at your school? (Open)

This is the end of the survey, thank you for your participation.
If you are interested in being registered for the drawing for a $50 gift card to Amazon (or similar) please click here. --Link to be inserted—

Appendix E: Teacher Funding for Science Instructional Materials Interview Protocol

Thank you for agreeing to speak with me today. The purpose of this interview is to gather information about funding and resources in high school science classrooms. The interview will last about 15 minutes and I will record the discussion to make sure it is documented accurately.

Do you have any questions before we begin?

1. When thinking about funding for the 2016-17 school year:
    - How much money did the science department receive? How was it spent?
    - Were there items purchased that are used by all the science teachers? (Ex. microscopes, goggles)
    - How much money did you get for instructional materials?
    - What did you spend your money on?
    - Who decides the amount of money each department gets? What informs that decision?
    - Who decides the amount of money each teacher gets? What informs that decision?
    - When you think about funding, what are all the factors?
    - Do you know if other content areas (ex. math, English, social studies), receive the same amount as science? Should they?
    - Did you spend any money out of pocket? How much?
2. If there were plenty for your instruction of funds what would be different about your teaching or instructional planning?
3. Do you feel of the amount of available money for instructional supplies affects your personal motivation or morale?
4. What is the process of funding in your particular school? Do you understand the flow of money from the taxpayer to school? Probe.
5. Have you changed lessons this year due to a lack of instructional supplies or funding? Tell me more about that? How did you feel? What did you do?
6. When you think about issues related to instructional supplies for science teachers, what do you think education leaders and the public should consider?
7. Do you think you have sufficient money to provide high quality instruction for your students? (Why or why not?)
8. If you need more money for science instructional materials, who would you go to?
9. What do you consider to be high quality instruction for science? Do you feel that you have sufficient funding to provide high quality instruction?

Appendix F: Questionnaire Consent Form

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study: Funding and Instructional Materials in Science Classrooms Questionnaire
Principal Investigator: Emily Cayton Faculty Sponsor: Dr. Gail Jones

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue.
You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
The purpose of the study is to understand how decisions are made regarding funding for instructional materials for science classrooms. Your experiences and perspectives are needed to help inform the educational budgeting process. Your responses will be anonymous, no one will know who filled out the survey.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to you will be asked to participate in a 10-minute questionnaire to take place at a time and location convenient for you. Participation is entirely voluntary and no names of participants will be used in this study. All information gathered will be used only for this research study and only the researchers will have access to the data.

Risks and Benefits
There are minimal risks associated with participation in this research. There are no direct benefits to your participation in the research. The indirect benefits are to help educators better understand funding and instructional material allocations for science classrooms.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely in Google Drive. No reference will be made in oral or written reports which could link you to the study.

Compensation
For participating in this study you will be entered into a drawing for a $50 Amazon gift card (or similar). If you withdraw from the study prior to its completion, you will not be entered into the drawing.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher, Emily Cayton or Dr. Gail Jones, at NCSU, Box 7801, Raleigh, NC 27695-7801, or 919-515-4053

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator at dapaxton@ncsu.edu or by phone at 1-919-515-4514.

Consent To Participate
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

Click Yes to consent and continue with the questionnaire.

Appendix G: Interview Consent Form

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study: Funding and Instructional Materials in Science Classrooms Interview
Principal Investigator: Emily Cayton Faculty Sponsor: Dr. Gail Jones

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue.

You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
The purpose of the study is to understand how decisions are made regarding funding for science instructional materials. Your experiences and perspectives are needed to help inform the educational budgeting process. Your responses will be anonymous.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to participate in a 30-minute audiotaped interview to take place at a time and location convenient for you. Participation is entirely voluntary and no names of participants will be used in this study. All information gathered will be used only for this research study and only the researchers will have access to the data.

Risks and Benefits
There are minimal risks associated with participation in this research. There are no direct benefits to your participation in the research. The indirect benefits are to help educators better understand funding and instructional material allocations for science classrooms.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. No reference will be made in oral or written reports which could link you to the study. Audio recordings will be stored in an encrypted file location on Google Drive and will be destroyed after transcription.

Compensation
You will not receive anything for participating in this study.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher, Emily Cayton or Dr. Gail Jones, at NCSU, Box 7801, Raleigh, NC 27695-7801, or 919-515-4053.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator at dapaxton@ncsu.edu or by phone at 1-919-515-4514.

Consent To Participate
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."