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Teaching Algebra: A Comparison of Scottish and American Perspectives

Brittany Munro

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By

Brittany Munro
University Honors Scholars Program
East Tennessee State University

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Brittany Munro, Author

_____
Dr. Ryan Nivens, Faculty Mentor

_____
Dr. Jeff Knisley, Faculty Reader

_____
Dr. Stephen Fritz, Faculty Reader

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Chapter 1

Introduction

In college education classes, curriculum focuses on teaching future educators about different pedagogical techniques and philosophies of learning. The topic that is almost never discussed in these classes is how a teacher actually decides what techniques to implement in order to most effectively facilitate student learning in their classroom. Although there are several factors that could influence a teacher's decision to employ certain techniques, most researchers focus on external factors such as student learning styles and availability of resources. However, instead of looking at these external factors, a major influence on a teacher's decisions could be more intrinsic. Particularly with the subject of mathematics, a teacher's perception of the subject matter and of the current state of the field could affect a teacher's pedagogical choices. For example, how a teacher views the role of mathematics in the "real world" could heavily influence whether that teacher chooses to employ a strategy that emphasizes rote procedures rather than word problems.

Furthermore, the culture a teacher is living and working in could influence that teachers perception of mathematics and his or her choice of teaching strategy. As I began to research teachers' pedagogical choices, I became very interested in why teachers made certain decisions. How did their personal beliefs and views concerning mathematics impact their teaching methods? Moreover, I wondered if these views and choices of teaching strategy might vary depending on the country or culture in which the teacher works. For instance, as I first started researching, I wondered how the perceptions and choices of a teacher in a fairly large and diverse country like the United States might differ from that of a teacher in a smaller more homogeneous country like Scotland. However, for an undergraduate project of limited time and resources, I was forced to restrict the scope of my project. Having grown up in East Tennessee and having studied the Southern Appalachian region, I decided to limit my research to this area of the United States. Furthermore, this region of Appalachia is similar to Scotland in that both are mountainous and rural areas with a homogeneous population.

In addition, many Appalachians are descendants of Scots-Irish settlers. Due to this ancestral connection and the similarities of Scotland and Appalachia, I determined to limit my study of mathematics education to teachers in these areas.

As a result of my interest in these matters, I first wanted to learn how a teacher's perception of mathematics influenced the strategies that he or she employed while teaching algebra. Secondly, I wanted to learn how those perceptions and pedagogical choices of teachers in the United States, primarily in Appalachia compared to those of teachers in Scotland. Thus, the purpose of this study is to ascertain these perceptions and pedagogical choices of Scottish and Appalachian teachers. In order to do so, an anonymous survey was conducted. Teachers from both regions voluntarily participated in the survey, and by doing so, they consented to having their responses included in this study. This paper analyzes the responses of the teachers, both quantitatively and qualitatively. The results will be analyzed qualitatively for common themes in the perceived determinant of mathematical success and the strategy or strategies teachers employ most often. Furthermore, the results will be analyzed quantitatively to determine similarities and differences between the responses of Scottish and Appalachian teachers.

Significance

Understanding a teacher's perceptions of mathematics and choices in pedagogical strategies can help current professionals and future educators to determine better ways of facilitating student learning. In looking at past research, it is clear that the successful teaching of mathematics is crucial to student achievement [1]. However, gaps in research are also evident. What particularly influences a teacher's pedagogical choices? My research on teachers' perceptions should help to fill in some of these gaps by focusing on teachers' beliefs and choices concerning the subject matter rather than just the opinion of students as many past studies have done [9, 15]. Furthermore, focusing on more similarly structured, but differently populated countries such as the United States and Scotland could better show how culture and teacher perceptions shape educational strategies. For instance, the United States and Scotland are similar in that they both are well-developed nations, teach predominately in English, and have national standards. However, the United States has a much larger more diverse population than that of Scotland.

First, the United States and Scotland are both well-developed nations in that they provide funding for the universal education of their student populations. For instance, federal laws and grants give billions of dollars annually to American

schools. During the 2010-11 school year, taxpayers invested an estimated $632 billion in K-12 education, which is approximately $12,600 per American student [12]. Meanwhile, in Scotland, an estimated 19% of of the country's public service spending went towards the funding of education during the 2011-12 fiscal year [3]. The majority of schools receive some sort of financial support from the Scottish government, usually from taxes or grant money [13]. In both the United States and Scotland, the government is the primary source of funding for education.

Furthermore, the United States and Scotland both predominately teach in English. Despite a very diverse population, in the United States, English is the primary language of education. Upon reaching middle or high school, most American students take some sort of foreign language to supplement their education, but one English class per year remains a requirement for all students grades K-12. The United States also has English Language Learner programs in which students are occasionally taught with other languages such as Spanish, German, or whatever that student's native language may be. However, the primary purpose of these programs is to teach and improve the English language proficiency of non-native English speakers [11]. Meanwhile, in Scotland, it has been a long held belief that English was the only language in which students needed to be proficient. Although the Scottish languages of Gaelic and Scots do influence some schools, English remains the primary language for teaching [6]. Both countries are currently trying to expand education to be more inclusive of foreign language while maintaining dependence on English as the primary language.

Finally, the United States and Scotland both have nearly national standards. For instance, forty-four states in the U.S. have adopted the Common Core Standards for mathematics and English language arts. State officials from forty-eight states, two territories, and the District of Colombia, in connection with the National Governors Association and the Council of Chief State School Officials, created the Common Core Standards in 2009 [4]. Their hope in creating these standards was that regardless of location students would be prepared for a future in higher education or in the job market. Similarly, in Scotland, the government has endorsed but not required the adoption of national standards called "Curriculum for Excellence." Like Common Core, the purpose of Curriculum for Excellence is to prepare students for life after school, whether that be higher education or a career [14].

Overall, this study is significant because algebra is an important discipline to both learn and teach. It is crucial that teachers discover which pedagogical strategy or combination of strategies works best for specific students as they work towards a strong algebraic foundation because algebra skills are the foundation for higher-level math classes as well as many everyday tasks. For instance,

mathematics plays a vital role in many jobs such as engineering, health care, and statistical analysis. If students do not receive the proper algebraic foundation, they will have even more difficulty succeeding in higher-level mathematics classes at university, which in turn will limit job opportunities. In addition, for students who do not go on to higher-level math classes, competence and confidence in algebra skills remain important. Many algebraic principles are used throughout everyday life such as in making budgets, estimating supplies, and simply understanding the world around us. The algebra that a student learns in school is the formal notational language and structured thinking used to accomplish these tasks. For instance, the entire world can be modeled in terms of equations, and many world problems can be studied or solved using mathematical skills and algorithms. Without a strong foundation in algebra, students will have difficulty succeeding in an increasingly math-based world.

Chapter 2

Literature Review

Fears that the United States has been falling behind in mathematics and science have been rampant since the Cold War. The Soviet launch of Sputnik in 1959 particularly spurred a need for educational reform. In the decades following Sputnik, mathematicians, educators, and politicians launched a heated battle over the best way to reform mathematics education. To this day, there is division between those who believe in discovery learning and those who advocate direct instruction as the best way to increase student success [10]. With the recent adoption of the Common Core State Standards by forty-four states [4], mathematicians, politicians, scientists, and educators continue the struggle to find the best pedagogical strategies for the mathematics curriculum in the United States.

Furthermore, as the world progresses further into the 21st Century and the age of technology, a strong foundation in mathematics is becoming increasingly important [5]. Mathematics is entrenched in almost every aspect of education and daily life as many careers including nursing, engineering, design, and accounting use mathematics in everyday tasks. Furthermore, most research projects depend on statistics to calculate risks and advantages and to analyze data. In everyday life, individuals estimate distances, supplies, and budgets and simply try to understand the world around them. All of these activities are firmly rooted in mathematics, albeit not higher-level mathematics such as calculus, but they are definitely rooted in algebra. These skills of estimation, logic, and problem-solving are taught in algebra classes around the world, and they are crucial skills to an individual becoming a successful student and citizen.

Algebra is pervasive in our society and despite its vital role in intellectual and technological progress, there remain many problems in the field of math education. As a result, many researchers have turned to studying different aspects of math education in countries around the world to determine these problems

and their potential solutions. The most prevalent problems seem to be student disinterest in mathematics and inadequate teaching time [5], preconceptions of ability or lack thereof [15], inability to understand word problems and the use of diagraming to solve them [9], lack of teacher knowledge and flexibility [8], and inefficient use of calculators [7]. Although technology is important, too often students use calculators as a crutch rather than a supplementary learning tool. For instance, a study done at John Hopkins University led two professors to the discovery that students whose K-12 education "emphasized and encouraged" calculator usage earned lower grades in their college math classes while their peers whose K-12 education "taught, but did not push" calculators earned higher grades in the same classes [16]. Students need to understand the mathematical logic behind the technology rather than simply depending on the calculators for answers. Solutions to these problems include teaching efficient and appropriate use of calculators [7], allotting more time for mathematics classes [5], raising standards of high school and college preparatory math classes [2], and shrinking the number of big topics covered. For instance, mathematicians and professionals suggest shrinking the number of topics covered in a year to a smaller number, so that students are able to build a stronger foundation for a few important topics instead of a weak foundation for numerous topics [10].

These past studies have worked towards the betterment of mathematics education but there remains much to be done. As mentioned above, there are several problems currently impeding student learning, while the necessity for mathematical knowledge is increasing. Filling in the gaps of past research could lead to a clearer picture of how best to solve these problems. Furthermore, instead of just studying students and measures of their success, research should take a closer look at teacher backgrounds, perspectives, and choices. As one algebra teacher put it when asked about what influences the success of his students the most, "Everything depends on the teacher's knowledge and dispositions...In one word, it is the philosophy that one has about the teaching of mathematics" [1].

Chapter 3

Research

Approval from East Tennessee State University's Institutional Review Board was obtained prior to conducting this study.

Population and Sample

The requirements to be a participant in this study were to be 18 years or older and a mathematics teacher in either the United States or Scotland. The method for locating potential participants varied based on the country. In the United States, potential participants were located by collecting teachers' email addresses from public school websites. The majority of the American teachers were from public schools in East Tennessee. Meanwhile, in Scotland, a point of contact was made with a professor at the University of Stirling. This professor agreed to distribute the survey to several mathematics teachers in his area via email. Potential participants were emailed an informed consent letter with a secure link to an online survey. By clicking the link, the teachers agreed to be voluntary participants in this study.

Methods and Instruments

In order to determine each teacher's perceptions and strategies from both the United States and Scotland, participants voluntarily completed an anonymous online survey. By utilizing this instrument rather than an interview, external pressures that could potentially constrain the participants' answers were eliminated or, at the very least, reduced. For instance, by having the survey online and anonymous, teachers had an open forum in which to divulge their opinions without the pressure of having another person present, potentially judging their answers. Furthermore, having the survey online allowed teachers to take the

survey at their leisure. In giving participants this freedom, it was hoped that the teachers would provide more thoughtful and accurate results that could not have been achieved under other research formats.

The survey consisted of twenty-three questions total. It comprised two free response questions, four multiple-choice questions, and seventeen Likert scale items. Research concerning past studies as well as the state of mathematics education inspired the majority of the survey questions. The questions not based on research were primarily a result of my own curiosity and perceptions of the field of mathematics education.

The survey was designed and created through surveymonkey.com, which is a secure password protected website. Once the survey was finalized, surveymonkey.com created a secure link to the survey that could be emailed out to participants. The secure link was embedded in the informed consent letter emailed to the teachers of each country (See Appendix A). On January 20, 2014, this letter was sent to American teachers through their email address collected from public school websites and to Scottish teachers through my contact professor at the University of Stirling. In both countries, if the teachers clicked on the secure link, they confirmed their consent to participate in the survey and to have their responses analyzed in this study. Once the teachers clicked on the link, they were taken to a secure webpage where they could complete the survey anonymously. Upon clicking submit, their answers were automatically collected by surveymonkey.com. At this point, the responses were downloaded into an excel spreadsheet to be analyzed both quantitatively and qualitatively. The last response collected and used as raw data was obtained on February 27, 2014.

Chapter 4

Results and Discussion

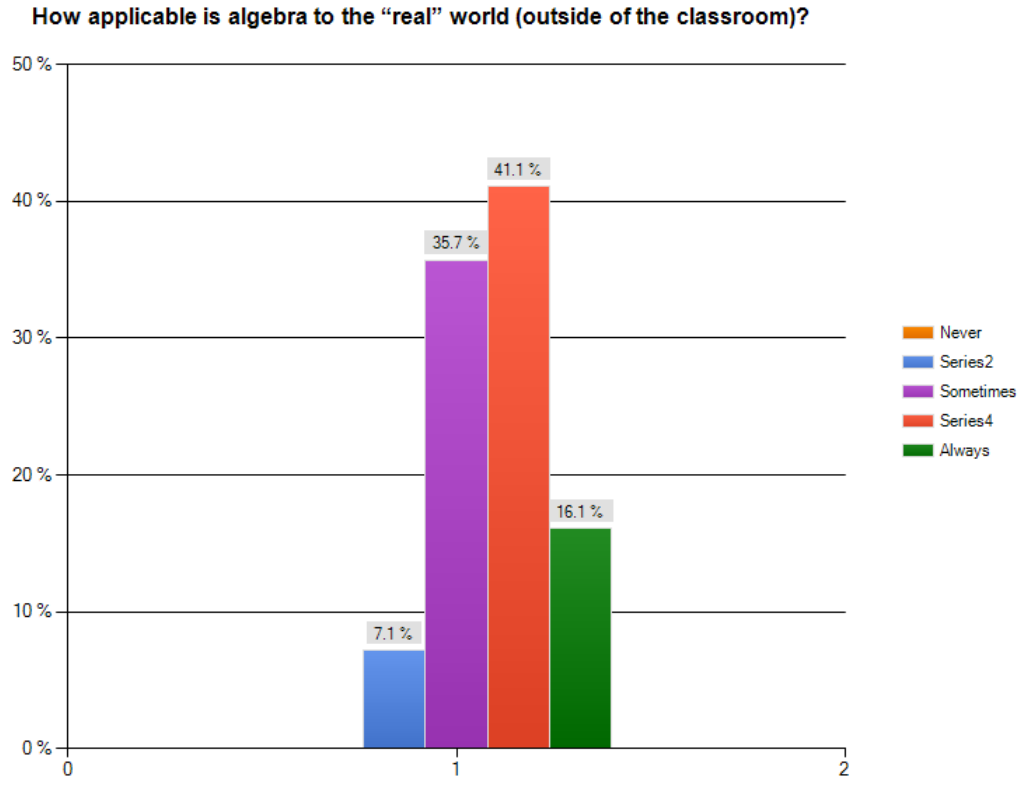
Although I would estimate the total number of surveys sent out at approximately one hundred, the total number of teachers to receive the survey is unclear for a number of reasons. In the United States, some principals and teachers forwarded the survey to an additional unknown number of their colleagues. Meanwhile, it is unknown how many Scottish teachers received the survey as this information was not divulged to me by my point of contact. There were a total of fifty-six responses to the survey. Seven responses came from Scottish teachers, and forty-nine responses came from American teachers. Although more responses were expected, time constraints on the research period limited the number of responses. It is believed time constraints and distance played a role in the limited number of responses from Scotland. However, the responses received were analyzed as is.

Of the twenty-three questions on the survey, only twenty-two were analyzed for common themes. Question (2) on the survey was thrown out due to most participants misunderstanding of the question. It asked, "How much of the school day is devoted to mathematics? (in hours)." The responses varied from one hour to all day implying that the respondents were unsure whether the question pertained to how long they personally devoted to mathematics or how long a single class period was devoted to mathematics. As a result of the varied responses and confusion, the results could not be analyzed with accuracy, and the question was therefore discarded. The remaining twenty-two questions were analyzed quantitatively and qualitatively and can be split into three categories: teaching strategies and methods, factors in student learning, and additional comments from the teachers.

Teaching Strategies and Methods

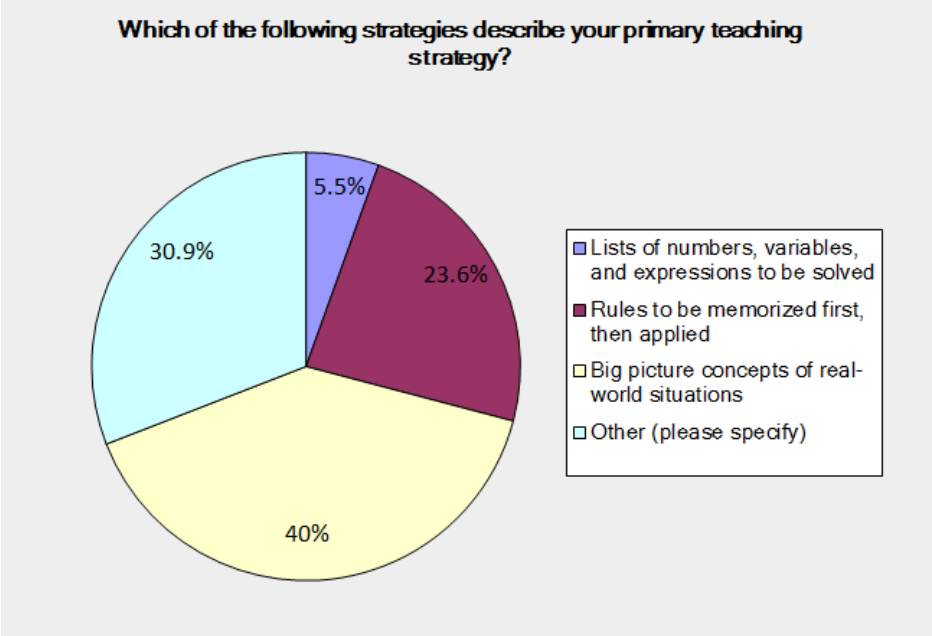
In this section, the questions pertained to the teachers' perception of mathematics and the different pedagogical strategies that they employ in their classrooms. Seven questions (six Likert items and one multiple choice) were analyzed to determine how the teachers' perceptions affected their pedagogy.

One of the Likert items asked the teachers how applicable they think mathematics is to the "real world" or outside of the classroom. The purpose of this question was to establish the teachers' perception of their subject matter. The chart below summarizes the total responses of teachers in both countries.



In particular, of the Appalachian teachers, 16.3% said mathematics is always applicable to the "real world", 42.9% said almost always, 34.7% said sometimes, and 6.1% said it is almost never applicable. Meanwhile, 14.3% of the Scottish teachers said mathematics is always applicable; 28.6% said almost always, 42.9% said sometimes, and 14.3% said it is almost never applicable to the "real world". No one from either country responded that mathematics was never applicable.

The multiple choice question, Question (3), asked of the teachers what main strategy they employ when teaching algebra. The overall responses of teachers from both countries are summarized in the chart below.



But when we break it down by country, responses from 41.7% of the Appalachian teachers said they taught through concepts involving "real world situations", 22.9% taught "rules to be memorized first, then applied", 4.2% of the teachers taught using "lists of numbers, variables, and expressions to be worked", and 31.2% said they used other strategies or some combination of the aforementioned strategies. For instance, under the option of other, the survey allowed teachers to leave a comment. In this section, five Appalachian teachers commented that they allowed their students to discover the "rules to be memorized" and then had students apply the discovered rules to "real world situations".

Meanwhile, of the Scottish teachers, 28.6% said they taught using "real world situations", 28.6% said they taught rules and then had students apply them, 14.3% said they taught through using list of expressions to be solved, and 28.6% said they employed another strategy. In the comments section, one teacher claimed to use an investigation or discovery approach, and another teacher described using a mixture of the mentioned strategies.

These pedagogical choices seem to be consistently emphasized by teachers from both countries as shown by responses to four of the Likert items that pertain to the different strategies commonly utilized by algebra teachers. These five questions attempted to elaborate on the teacher's choice of strategy by ascertaining

how often he or she utilized strategies associated with either lecture or problems-based approaches. The findings for these four questions are summarized below.

Question		Never		Sometimes		Always
How often do you use a problems-based approach when teaching mathematics?		0.0%	1.9%	26.8%	**62.5%**	8.9%
	Scotland	0.0%	0.0%	**71.4%**	28.6%	0.0%
	United States	0.0%	2.0%	20.4%	**67.3%**	10.2%
How often do students use visuals (charts and diagrams) to solve word problems?		0.0%	3.6%	37.5%	**41.1%**	17.9%
	Scotland	0.0%	0.0%	42.9%	**57.1%**	0.0%
	United States	0.0%	4.1%	36.7%	38.8	20.4%
*How often do you use lecture-style teaching?		1.8%	10.9%	**47.3%**	40.0%	0.0%
	Scotland	0.0%	28.6%	**42.9%**	28.6%	0.0%
	*United States	2.1%	8.3%	**47.9%**	41.7%	0.0%
How often are word problems emphasized?		0.0%	5.4%	21.4%	**60.7%**	12.5%
	Scotland	0.0%	0.0%	**42.9%**	**42.9%**	14.3%
	United States	0.0%	6.1%	18.4%	**63.3%**	12.2%

An * beside the question tells how many times the question was skipped in the survey.

Overall, from these findings, it seems that the teachers' dominant strategy is using "real world" concepts and problems to teach their students the fundamental theories and applications of algebra. Of the Appalachian teachers, 67.3% said that they almost always use a problem-based approach. However, it is interesting to note that one Appalachain teacher did respond that he or she almost never employs a problems-based approach. Meanwhile, five of the Scottish teachers said they sometimes use a problems-based approach and two said they almost always use a problems-based approach. Even though the data is small, it seems that a problems-based approach is central to mathematics education in Scotland, just like it is in the United States.

Furthermore, the responses imply that the teachers occasionally used a lecture approach in order to supplement the problems-based approach. Of the Appalachian teachers, 47.9% said they sometimes use lecture-based teaching methods and 10.4% said they never or almost never use lecture methods. Of the Scottish teachers, two almost never, three sometimes, and two almost always utilize a lecture strategy. From these responses, it seems that teachers from both countries utilize lecture methods as a supplementary approach in order to convey important terminology and rules to be applied to the real world situations.

The most troubling strategy discovered from the analysis of the survey responses is that the majority of teachers from both countries allow their students to use calculators without restraint. Of the Appalachian teachers, 40.4% or nineteen

teachers said they always allow their students to use calculators. Only two Appalachian teachers said they almost never allow their students to use calculators and zero responded with never. Meanwhile, of the Scottish teachers, three said they sometimes allow their students to use calculators and four said they almost always allow calculators. This is particularly troubling considering the results of the 2004 John Hopkins study. It is unclear how exactly calculators are utilized in these classroom, but this high level of calculator usage could lead to concerns over high school students' dependence on calculators. This dependence could inhibits students ability to understand and complete higher-level mathematics as well perpetuate inefficient use of technology [7, 16]. Although Scottish teachers seemed to show more restraint with calculators, both countries responses still illustrate a high level of dependence on calculators that could inhibit student learning.

Factors in Student Learning

This section contains twelve questions (two multiple choice and ten Likert items). These questions are meant to ascertain the key factors that influence student learning, and more particularly, teacher perceptions concerning the frequency of such problems.

The teachers were asked two multiple-choice questions about what factors might influence student learning. For instance, Question (4) asked whether positive or negative motivators more powerfully stimulated students to learn algebra. The survey defined negative motivators as fear of punishment or bad grades, whereas positive motivation was defined as the desire to do well on an assignment or the desire to please a parent and/or teacher. Based on these definitions, only one Appalachian teacher said negative motivators were more powerful while 81.6% said positive reinforcement. In addition, 16.3% of Appalachian teachers responded that positive and negative motivators contribute equally to student motivation. Similarly, six Scottish teachers said positive reinforcement was more powerful, and one responded both. From these results, it is clear that teachers from both countries perceive positive motivators as the primary motivation for student learning. They perceive fear to be a very poor motivator when it comes to student performance.

The second multiple-choice question, Question (5), asked teachers whether effort or innate intelligence influenced students' mathematics performance more. Of the Appalachian teachers, 89.6% responded effort, none said innate intelligence, 10.4% said "other", and one teacher skipped the question altogether. Those who responded "other" left commentary that illustrate the belief that a combination of innate intelligence and effort influences student performance. To sum up

the comments, most teachers believed that students have to be willing to learn mathematics in combination with some mastery of prior skills, especially as students begin upper level mathematics courses. Of the Scottish teachers, six said effort, and one said "other" with the comment that both effort and innate intelligence hold an equal influence over students' mathematics performance. Both American and Scottish teachers agree that student effort plays a vital role in a student's academic performance.

In order to elaborate further on how these factors in mathematics education affect student learning, the remaining ten Likert items focused on four broad categories of factors that influence student learning. These categories pertain to the student, the school, the parents, and the teacher.

First, the teachers were asked how a students attitude and background influenced student learning. The raw data for these questions are summarized in the table below.

Question		Never		Sometimes		Always
How influential is student attitude/behavior in student achievement?		0.0%	0.0%	3.6%	39.3%	**57.1%**
	Scotland	0.0%	0.0%	0.0%	42.9%	**57.1%**
	United States	0.0%	0.0%	4.1%	38.8%	**57.1%**
How influential is a student's social background in student achievement?		0.0%	8.9%	**62.5%**	17.9%	10.7%
	Scotland	0.0%	14.3%	**57.1%**	28.2%	0.0%
	United States	0.0%	8.2%	**63.3%**	16.3%	12.2%

The majority of teachers from both countries saw student attitude as almost always or always influencing student achievement. For instance, in the United States, 95.9% of teachers chose these levels of influence whereas 100% of Scottish teachers perceived student attitude as almost always or always influencing student achievement. Although teachers from both countries saw student attitude as significant, they perceived a student's social background as having a more minimal effect on student achievement. For instance, 63.3% of Appalachian teachers responded that a student's background sometimes affects their performance, whereas 57.1% of Scottish teachers responded with sometimes. Furthermore, Appalachian teachers seemed to see social background as having more of an effect than Scottish teachers have as 28.5% of Appalachian teachers viewed social background as always or almost always influencing a student's performance. From both of these questions and their responses, it can be deduced that teachers view the student as playing a significant role in his or her academic performance.

Next, the survey asked how school factors such as availability of resources, funds, and time influenced student learning. The raw data for these questions are summarized in the following chart.

Question		Never		Sometimes		Always
How influential is scarcity of school resources and/or funding in student achievement?		0.0%	17.9%	**53.6%**	21.4%	7.1%
	Scotland	0.0%	14.3%	**42.9%**	28.6%	14.3%
	United States	0.0%	18.4%	**55.1%**	20.4%	6.1%
How influential is inadequate amount of teaching time in student achievement?		0.0%	1.8%	28.6%	**44.6%**	25.0%
	Scotland	0.0%	0.0%	28.6%	28.6%	**42.9%**
	United States	0.0%	2.0%	28.6%	**46.9%**	22.4%

Of the Appalachian teachers, 55.1% said scarcity of school resources and funding is sometimes influential, and 20.4% said it is almost always influential. Similarly, of the Scottish teachers, 42.8% said sometimes and 28.5% said almost always. From both countries, zero participants said that lack of school resources never factors into student achievement. Moreover, zero participants responded that an inadequate amount of teaching time never influences student achievement. Of the Scottish teachers, 71.4% said time constraints always or almost always influence student achievement, and 46.9% of Appalachian teachers said limited time almost always affects student learning. These statistics are significant because it illustrates how factors that are out of a teachers control are perceived as having a very strong influence over student achievement. The fact that the majority of teachers saw these factors as almost always or always influencing student achievement shows the significant constraints placed on a teacher's ability to efficiently convey mathematical content to their students.

In addition, the survey attempted to ascertain teacher perspectives on the effect of parental involvement and expectations on student learning. The raw data for these questions are summarized in the table below.

Question		Never		Sometimes		Always
How influential is parental expectations in student achievement?		0.0	3.6%	32.1%	**44.6%**	19.6%
	Scotland	0.0%	14.3%	28.6%	**57.1%**	0.0%
	United States	0.0%	2.0%	32.7%	**42.9%**	22.4%
*How influential is parental support and involvement in student achievement?		0.0%	0.0%	23.6%	**50.9%**	25.5%
	Scotland	0.0%	0.0%	28.6%	**57.1%**	14.3%
	*United States	0.0%	0.0%	22.9%	**50.0%**	27.1%

Of the teachers in the United States, 77.1% said parental support and involvement is always or almost always a factor in student achievement. Meanwhile, 57.1% of Scottish teachers said parental support is almost always a factor, and one teacher said always. Although these statistics seemed to show the teachers' belief that parents are an active influence in their childs education, the teachers did not perceive parental expectations as having as significant an impact. Of the Appalachian teachers, 65.3% said parental expectations almost always or always influence student achievement. This is down over 10% from the number of teachers who believed parental support was very influential. Meanwhile, of the Scottish teachers, 57.1% still believed parental expectations almost always

influence student achievement, but one teacher responded that parental expectations almost never carries influence. Although the statistics did drop, it can still be concluded that teachers from Scotland and the United States agree that parents play an influential role in student performance.

Finally, the survey examined how the participant perceived his or her own expectations and knowledge as influencing their students' learning. The raw data exploring the perceptions of a teacher's impact on student achievement is summarized in the table below.

Question		Never		Sometimes		Always
How influential is the teacher's lack of fundamental mathematics knowledge in student achievement?		1.8%	1.8%	19.6%	28.6%	**48.2%**
	Scotland	0.0%	0.0%	**57.1%**	28.6%	14.3%
	United States	2.0%	2.0%	14.3%	28.6%	**53.1%**
How influential is lack of knowledge of teaching design (how to structure lessons, etc.) in student achievement?		1.8%	1.8%	21.4%	**44.6%**	30.4%
	Scotland	0.0%	0.0%	28.6%	**42.9%**	28.6%
	United States	2.0%	2.0%	20.4%	**44.9%**	30.6%
*How influential is failure of teacher strategy (lesson is unsuccessful) in student achievement?		0.0%	7.3%	27.3%	**40.0%**	25.5%
	Scotland	0.0%	0.0%	14.3%	**57.1%**	28.6%
	*United States	0.0%	8.3%	29.2%	**37.5%**	25.0%
How influential is teacher expectations in student achievement?		0.0%	0.0%	14.3%	**51.8%**	33.9%
	Scotland	0.0%	0.0%	14.3%	**57.1%**	28.6%
	United States	0.0%	0.0%	14.3%	**51.0%**	34.7%

An * beside the question tells how many times the question was skipped in the survey.

In the United States, 4% of teachers said a teacher's knowledge of mathematics never or almost never influences student achievement, and 53.1% of Appalachian teachers said a teachers mathematics knowledge always influences student achievement. On the other hand, zero Scottish teachers responded that a teacher's knowledge never influences student achievement, and 57.1% saw a teacher's knowledge of mathematics, or lack of knowledge, as sometimes influencing student achievement. Furthermore, teachers from both countries seemed to view knowledge of teaching design as carrying some weight but not as much as a teachers knowledge of the subject matter. For instance, 44.9% of Appalachian teachers said knowledge of teaching design almost always affects student learning while 42.8% of Scottish teachers said knowledge of teaching design almost always affects student learning. Although the participants view teaching design such as planning lessons and strategies as important, ultimately they perceive a teacher's knowledge of the subject matter as more influential.

Furthermore, teachers were asked how often failure of teaching strategy such as a lesson being unsuccessful influenced student achievement. Of the Appalachian teachers, 8.3% responded that failure of teaching strategy almost never influences student learning, 29.2% responded sometimes, and only 25.0% responded that

it is always significant. Meanwhile, the Scottish teachers viewed strategy as more significant. For instance, 57.1% of Scottish teachers said failure of lessons almost always influences student learning, 14.2% said sometimes, and 28.5% said it always influences student learning. Zero Scottish participants responded that this failure on the teacher's part never carries weight. These statistics illustrate that the Scottish teachers more than American teachers perceive the success of a lesson as being a significant factor in student achievement.

Lastly, teachers were asked about how a teacher's expectations for their students affects student performance. Of the Appalachian teachers, 51.0% said their expectations almost always influence student learning and 34.7% said always. Similarly, of the Scottish teachers, 57.1% said teacher expectations almost always influence student learning and 28.5% said always. Teachers from both countries seem to view the teacher as playing a very influential role in student performance.

From examining all of these factors and statistics, one can deduce an order of significance that the teachers attribute to each of the four categories. For instance, the majority of teachers seem to agree that the categories can be arranged in the following order from most significant to least significant: the student, the teacher, the parent, and finally the school. The student factor, more specifically the student's attitude and behavior, is most significant to the teachers polled, and this is closely followed by the significance of the teacher, particularly his or her expectations and knowledge of the subject matter. The teacher and student probably carry the most influence because of their proximity and direct interaction with the learning environment. Moreover, while parental support and school resources were perceived as definitely carrying influence, their effect is more indirect and thus less apparent. As one teacher said, regardless of resources, if the child wants to learn and the teacher wants to teach, there will be academic achievement.

Additional Comments

At the end of the survey, teachers were given the option to leave an additional comment concerning anything in the survey. Only one teacher from Scotland left a response. However, that response reflected a belief that the student plays the most pivotal role in his or her own academic achievement. The participant said that, "A 'good teacher' can always get the point across regardless of the resources, textbooks, etc. provided. One of the biggest factors regarding how well the pupils achieve is to do with their own personal attitude. If they don't want to learn they won't. The question this raises is how do you motivate?" This comment illustrates the teacher's belief that the student's attitude is the most influential factor in his or her academic performance, but the participant

also points to a need for further research, which will be discussed in the next section.

Meanwhile, seventeen of the Appalachian teachers left an additional comment on their surveys. Their comments range from how these factors in student learning fit together to what they perceive to be the biggest problems in today's field of mathematics education. For instance, one participant said, "These factors are intimately woven. The best chance for success is when they are working together. The student least likely to succeed has them all working against him." This reflects many of the teachers' perceptions as well as much of the survey results. There are numerous factors that determine whether a student is successful. Whether that is the student's effort, the teacher's knowledge and expectations, or the contributions of the school and parents, these factors all yield some level of influence over students' mathematical achievement. Regardless, the teachers seemed to agree that when the factors work together to improve student learning, a student can achieve anything that he or she desires.

Although a few of the Appalachian teachers seem optimistic that with effort and confidence their students could achieve "their hearts desire", many of the teachers also believe that there are many issues with the current state of mathematics education. For instance, the most notable comments reflected the participants' belief that students come to them at different levels and with different life plans. Many teachers believe that there is too much emphasis on college prep and not enough emphasis on real world usage of mathematics. Teaching to the test is perceived as one of the biggest problems because students are taught rote formulas and equations rather than real world knowledge that will help them outside of preparation for higher-level mathematics courses that most students do not go on to take. Their comments reflect the belief that students are at different levels and going different places, and therefore not every child needs the same mathematics knowledge as everyone else.

Chapter 5

Future Recommendations

From this study, one research gap concerning mathematics education has hopefully been filled in. From these teachers' responses, it is clear that American and Scottish teachers report using a primarily problems-based approach that emphasizes real world situations. Furthermore, it seems that these teachers believe that the student and the teacher are the most significant determinants in whether or not student learning is achieved. Although some questions have been answered by these conclusions, there is still much research to be done.

There are many aspects of the mathematics education field that need to be investigated further. Most notably, the effectiveness of the individual strategies, the effect of technology on student learning, the specific factors that affect student learning, and strategies for motivating students could all be a basis for future research studies. For instance, many of the teachers mentioned that they utilize a combination of lecture and application strategies in which they encourage their students to discover rules and formulas to be applied to real world situations. Further investigation of how effective this discovery method is could lead to progress in student achievement. Moreover, how this discovery method ties into the United States' Common Core Standards and Scotland's Curriculum for Excellence needs to be investigated. If necessary, these studies could lead to modifications in current teaching strategies that will augment the number of students reached through public education.

Other points for further research concern the specific factors discussed in this survey. Whole research studies could be done on each of the specific factors that influence student learning such as the expectations of parents and teachers, the background of students, and the availability of school resources, funding, and time. If each of these factors were studied separately and more in depth, educators would gain a better understanding of how to develop teaching strategies that would reach more students. By widening this berth of knowledge concern-

ing how to better facilitate student achievement and learning, researchers and educators could also find better ways of motivating students to want to learn mathematics and perform better in math-enriched settings.

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Appendix

The following pages contain the informed consent letter and survey as they were approved by the ETSU's Institutional Review Board and as they appeared to the participants of this study.

My name is Brittany Munro, and I am currently an undergraduate student of mathematics at East Tennessee State University. I am in the process of completing research for my honors thesis, in which I am conducting a survey of teachers' perceptions of mathematics and the teaching methods they use in the classroom. **I am asking teachers in the United States and in Scotland to complete the anonymous five-minute survey in the link at the end of this email.**

The purpose of my research is to analyze if and how teachers' perceptions of mathematics affect the teaching methods they choose to use in their classroom. In addition, I am analyzing how these perceptions vary between the math teachers in the United States and in Scotland.

Your participation in this research is voluntary. To volunteer you must be 18 years or older. The duration of your participation is limited to your responses in the survey. The results are completely anonymous, so there will be no way to link your specific results back to you. The only link to the survey will be the original email containing the survey. These records will be stored at the ETSU Honors House for at least five years and then subsequently destroyed. The results of this study may be published and/or presented at meetings without naming you as a subject.

If you have any questions or problems, you may call Brittany Munro at (423)834-0846 or email Brittany Munro at munrob@goldmail.etsu.edu. You may call the Chairman of the Institutional Review Board at (423)439-6054 for any questions you may have about your rights as a research subject. If you have any questions or concerns about the research and want to talk to someone independent of the research team or you cannot reach the study staff, you may call an IRB Coordinator at (423)439-6055 or (423)439-6002.

By submitting your responses to the survey, you confirm that you have read this document. You received the chance to ask questions and to discuss your participation with the investigator. You freely and voluntarily choose to be in this research project.

SURVEY: http://www.surveymonkey.com/s/6BSBRN8

Teaching Algebra

Teaching Algebra

Thank you for agreeing to participate in my survey! Your responses and contributions to my research are greatly appreciated!

1. Which country do you teach in?

- Scotland
- United States

2. How much of the school day is devoted to mathematics? (in hours)

3. Which of the following strategies describe your primary teaching strategy?

- Lists of numbers, variables, and expressions to be solved
- Rules to be memorized first, then applied
- Big picture concepts of real-world situations
- Other (please specify)

4. Which is the more powerful motivator for students to learn algebra?

- Negative (fear of punishment)
- Positive (desire to do well on test or desire for teacher/parent approval)
- Both

5. Which influences students' mathematics performance more?

- Effort
- Innate intelligence
- Other

Other (please specify)

6. How applicable is algebra to the "real" world (outside of the classroom)?

Never		Sometimes		Always

7. How often do you use a problems-based approach when teaching mathematics?

Never		Sometimes		Always

Teaching Algebra

8. How often do students use visuals (charts and diagrams) to solve word problems?

Never		Sometimes		Always
○	○	○	○	○

9. How often do you use lecture-style teaching?

Never		Sometimes		Always
○	○	○	○	○

10. How often are word problems emphasized?

Never		Sometimes		Always
○	○	○	○	○

11. How often do you allow students to use calculators in the classroom?

Never		Sometimes		Always
○	○	○	○	○

12. How often does tracking (classification of students as honors, special needs, etc.) play a role in the strategy you use?

Never		Sometimes		Always
○	○	○	○	○

13. How influential is the teacher's lack of fundamental mathematics knowledge in student achievement?

Never		Sometimes		Always
○	○	○	○	○

14. How influential is lack of knowledge of teaching design (how to structure lessons, etc.) in student achievement?

Never		Sometimes		Always
○	○	○	○	○

15. How influential is failure of teacher strategy (lesson is unsuccessful) in student achievement?

Never		Sometimes		Always
○	○	○	○	○

16. How influential is student attitude/behavior in student achievement?

Never		Sometimes		Always
○	○	○	○	○

17. How influential is parental expectations in student achievement?

Never		Sometimes		Always
○	○	○	○	○

Teaching Algebra

18. How influential is parental support and involvement in student achievement?

Never		Sometimes		Always
○	○	○	○	○

19. How influential is teacher expectations in student achievement?

Never		Sometimes		Always
○	○	○	○	○

20. How influential is inadequate amount of teaching time in student achievement?

Never		Sometimes		Always
○	○	○	○	○

21. How influential is a student's social background in student achievement?

Never		Sometimes		Always
○	○	○	○	○

22. How influential is scarcity of school resources and/or funding in student achievement?

Never		Sometimes		Always
○	○	○	○	○

23. Do you have any additional thoughts or comments on anything in the survey?