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Foreword by Douglas L. Wilson

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# Foreword

Especially for Americans, there is no escaping the influence of Thomas Jefferson. His imprint on things American is everywhere, even on the landscape. Observant air travellers flying from New York to Chicago, for example, will notice that the visible markings on the terrain become noticeably more rectilinear after crossing Pennsylvania. The reason is that from the state of Ohio westward the land was surveyed and laid out on a grid before settlement and sold or given out in rectangular plots. Lines created by this grid are still visible as roads or as the boundaries of fields, farms, towns, counties, and even states. This scheme was yet another brainchild of Thomas Jefferson, whose ideas and reforms issued forth in profusion during the early years of the American Republic.

Jefferson is best known, of course, as the author of the Declaration of Independence. Memorable for its statement of colonial grievances that constituted the rationale for the American Revolution, its bold affirmations of human rights and democratic values have made it a landmark of modern history. But the list of other memorable things Jefferson wrote or devised or promoted is long. He himself called attention to two of these, in addition to his authorship of the Declaration, in prescribing the inscription for his gravestone: his authorship of the Virginia statute for religious freedom, and the founding of the University of Virginia. Nothing about being elected Governor of Virginia or President of the United States or being responsible for the Louisiana Purchase, any one of which would have been sufficient to mark a truly notable career.

As an enthusiastic child of the Enlightenment, Jefferson concentrated on reforms that would contribute towards an educated citizenry and thus enhance self-government. To be successful, a democratic government needed an informed public. This required basic literacy and numeracy, which is why Jefferson pioneered as an advocate for common schools at public expense. His original plan actually provided for basic education but also for advanced training for the most talented students, who would then become the teachers and professionals needed to carry on the educational system and occupy the learned professions. The book in hand focuses on one of the many little-known reforms in this vein that Jefferson originated, namely, instituting a decimal system for money, as well as weights and measures. The traditional British units in both of these areas were notoriously arbitrary and not easily expressed arithmetically, making them burdensome to learn and use, and thus barriers to personal advancement. By contrast, a decimal system had the advantage not only of having a rationalized basis but of being much easier to learn.

But as the authors of this work make clear, in this particular reform Jefferson had to settle for half a loaf. While eminently successful in replacing the monetary system of pounds, shillings, and pence, his reforms in the fields of weights and measures were defeated. While some aspects of the existing systems seemed reasonable enough—a foot being comprised of 12 smaller units, for example—having 5,280 feet comprise a mile seems wholly arbitrary, and difficult to recall and employ. A teaspoon seems a reasonable measure to reckon with in certain situations, but that 768 teaspoons should make a gallon seems perverse. This would appear in retrospect to have been an especially vulnerable system for rationalization and reform, but except for scientific endeavors, it is largely still with us. The general adoption of the metric system has, in fact, been urged repeatedly, and there have been times when it appeared that America was on the verge of adopting it. In the 1970s, an American president,

Gerald Ford, even boasted that the United States was “miles ahead” in its adoption of the metric system, a characterization that ironically signaled the eventual failure of a scheme in which *miles* were to be replaced by *kilometers*.

The authors of this book make a notable contribution to Jefferson scholarship in a way that reminds us that the scholarly enterprise is a two-way street. Having drawn on the existing accumulation of what is known about Jefferson, they have substantially added to this store of knowledge by the application of their particular area of scholarly interest and expertise—the various ways that mathematics has been taught and learned in the past. Also remarkable in this regard is that this illuminating work on Jefferson comes on the heels of another work by the same authors that sheds new light on another subject of great interest—the education of Abraham Lincoln. In this instance, they have employed their highly specialized historical knowledge of cyphering books in mathematical education to interpret the earliest extant manuscripts in Lincoln's hand, which, properly understood, constitute what remains of his own cyphering book. In parallel to what they have done here for Thomas Jefferson, their distinctive background and experience has enabled the authors to contribute very significantly to our existing knowledge of Abraham Lincoln. An obvious lesson to be drawn from such developments is that what we call knowledge is not a static entity but rather an on-going process. And once again it is shown that in spite of the vast resources of time and effort that have been devoted to the study of these two historical giants, there is always more to learn.

Galesburg, IL Douglas L. Wilson

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# Overall Book Abstract, and Individual Abstracts for the Seven Chapters

## Overall Abstract

This book tells how decimal fractions moved from a place on the periphery of school mathematics in North America towards a more central place. The stimulus for this development was the introduction of an official decimalized Federal form of money, largely as a result of the efforts of Thomas Jefferson. The analysis establishes the fact that Jefferson believed that if the fledgling U.S. government would introduce a decimalized national currency, as well as a decimalized coordinated system of weights and measures, then this would greatly assist ordinary people to acquire the numerical skills that they would need to survive with dignity in most aspects of daily living in the United States of America. Although Jefferson's efforts to achieve decimal currency were successful, he was not able to overcome the vested interests of those who opposed the introduction of a coordinated, decimalized system of weights and measures. Some consequences of this failure are discussed in this book.

The following five research questions provided the foci for the study:

1. To what extent did policies and practices with respect to money influence school arithmetic curricula in the North American colonies before 1792?
2. To what extent did policies and practices with respect to weights and measures influence school arithmetic curricula in the United States of America before 1792?
3. To what extent did the place of decimal fractions in U.S. school arithmetic curricula change as a result of the introduction of a decimalized scheme of Federal money in 1792?
4. To what extent did policies and practices with respect to weights and measures play a part in school arithmetic curricula in the United States of America between 1792 and 1860?
5. What are the implications of the findings of this study for mathematics curriculum theory?

These questions are examined through the lens of a lag-time theoretical perspective which has been developed by the authors.

It was found that before 1792 school arithmetic in North America was largely controlled by a long-established cyphering tradition by which boys (and some girls), after they had reached the age of 10, prepared handwritten cyphering books in which the topics covered were mainly concerned with the four operations of arithmetic and with money and weights and measures. After the U.S. Congress approved the introduction of a decimalized form of Federal money, in the mid-1780s, and the national Mint was opened in 1792, students began to learn to carry out money calculations in eagles, dollars, cents, dimes and mills. But they also continued to learn how to make calculations with sterling currency denominations (pounds, shillings, pence and farthings) because, until well into the second half of the nineteenth century, sterling currency was still legal tender in the United States of America.

Analysis of cyphering-book data and of school textbooks used in North America between 1700 and 1810 revealed that although author-intended arithmetic curricula—as found in textbooks—in the United States of America, always included vulgar fractions and decimal fractions, entries on these topics were usually conspicuous by their absence in the teacher-implemented arithmetic curricula (as identified by analyzing cyphering books prepared by students). However, gradually, after 1792, a greater proportion of U.S. cyphering books included entries on decimal fractions. That gradual acceptance of decimal fractions is consistent with a lag-time theoretical position which predicted that, as a result of Jefferson's success in establishing a national, decimalized form of currency, schools were virtually compelled to teach their students about decimal currency—and from that situation it was a short step to getting students to study decimal fractions.

In Chapter 6, a comparative analysis of teacher-implemented arithmetic curricula in North America and Great Britain during the eighteenth and much of the nineteenth centuries is presented. This analysis led to the conclusion that, whereas in Great Britain there was no progress toward getting proportionally more students to study decimal fractions, in the United States, there was a steady growth in the proportion of students studying decimal fractions. That finding was consistent with predictions from the lag-time theoretical position.

From a mathematics education curricular perspective, perhaps the most important finding of the study reported in this book is that often there was a gulf between author-intended and teacher-intended arithmetic curricula. These large differences between the two types of curricula, which seem to have escaped the attention of previous historians, justify the claim, implicit in this book's subtitle, that the period 1775–1810 has been neglected so far as the history of school mathematics in the United States of America is concerned.

## Individual Chapter Abstracts

### Chapter 1: 1776: Dawn of a New Day in School Mathematics in North America

**Abstract:** The 1776 Declaration of Independence announced the dawn of a new day, for North America and, indeed, for the world. But did it herald new a new day for school mathematics? After describing how the term "school" was used in 1776 it is pointed out that at that time only a small proportion of North American adults had studied arithmetic beyond the four operations. The chapter examines the views of Thomas Jefferson on school education, in general, and on school mathematics, in particular. It is argued that it was within Thomas Jefferson's genius that a key to transforming school mathematics in the United States of America would be found.

### Chapter 2: The *Abbaco* Curriculum in Colonial Schools in North America Before 1776

**Abstract:** This chapter examines the extent to which arithmetic curricula in schools in North America before 1776 were concerned with calculations and problems involving money and weights and measures. Analyses of chapters in arithmetic textbooks (deemed to be "author-intended curricula") and handwritten entries in students' cyphering books (regarded as evidence of "teacher-implemented arithmetic curricula") reveal that tasks related to money and to weights and measures permeated what historians have called the *abbaco* curriculum. That curriculum influenced the way the content of arithmetic was structured and sequenced

in education institutions below the college level. The analyses also reveal that although money tasks and weights and measures tasks provided the principal emphases in school arithmetic, many students merely applied rules and methods which they did not understand.

## Chapter 3: Thomas Jefferson and an Arithmetic for the People

**Abstract:** This chapter focuses on U.S. currency issues, and policies, practices and reforms during the period 1775–1792. As a result of post-war agreements spelled out by the Treaty of Paris (1783), the fledgling U.S. Congress needed to establish an official currency for the new nation. At that time, the most powerful financial figure in the nation was Robert Morris, Superintendent of Finance between 1781 and 1784, but aspects of his proposal for a new currency system were problematized by the young, and influential Thomas Jefferson, already a former Governor of Virginia, and famous for having drafted the Declaration of Independence. Like Morris, Jefferson proposed a decimal-based system of coinage, but the units for Morris's and Jefferson's systems were different. It was Jefferson's system which prevailed, and the most startling thing about his success on this matter was that his fundamental argument belonged to the realm of mathematics education—a combination of mathematics and education. Jefferson argued that his system would assist all U.S. citizens to achieve a better grasp of basic arithmetic than ever before, and that that would make it easier for them to survive with dignity. This chapter summarizes Jefferson's main arguments for the introduction of his version of decimal currency, and why he thought educational issues were so important.

## Chapter 4: Weights and Measures in Teacher-Implemented Arithmetic Curricula in Eighteenth-Century North American Schools

**Abstract:** The decision having been made by the U.S. Congress to establish a decimal system of currency as the official national currency of the United States of America, one might have expected a decimal system of weights and measures to follow quickly. But that was not to be. Between 1784 and 1789 Thomas Jefferson was in France, and therefore his role as principal catalyst for decisions on decimalization was muted. The chapter begins by placing the weights and measures decision in the context of economic and political forces operating within the new nation. From a lag-time theoretical perspective, although there were numerous available arithmetic textbooks which dealt with decimal fractions, the prevailing economic and political pressures negated any educational and mathematical pressures for greater use of decimals. Thus, a curious result occurred—the United States decimalized its currency, but not its weights and measures.

## Chapter 5: Decimal Fractions and Federal Money in School Mathematics in the United States of America 1792–1810

**Abstract:** In the preface to his 1788 textbook, *A New and Complete System of Arithmetic, Composed for the Use of the Citizens of the United States,* Nicolas Pike wrote that "as the United States are now an independent nation, it was judged that a system [of arithmetic] might be calculated more suitable to our meridian than those heretofore published" (p. vii). A glance at the contents of Pike's book reveals that it did have features not usually found in

previous school arithmetics—for example, it included sections on logarithms, plain geometry, plain trigonometry, algebra and conic sections, and the sections on vulgar and decimal fractions appeared early in the book. But, Pike's book was rejected by many teachers as too difficult for most school children, and despite repeated calls for authors to write arithmetic textbooks which were specially designed for North American students, the most popular of the published arithmetics continued to emphasize the *abbaco*, commercially-oriented, arithmetic curriculum inherited from Europe. This chapter pays attention to immediate effects, during the period 1792–1810, that the introduction of a Federal, decimalized currency had on the author-intended arithmetic curriculum.

## Chapter 6: Decimal Fractions in School Arithmetic in Great Britain and North America During the Eighteenth and Nineteenth Centuries

**Abstract:** This chapter compares the extent to which decimal fractions were part of author-intended and teacher-implemented school mathematics curricula in Great Britain and in North America during the eighteenth and nineteenth centuries. It is assumed that what authors of arithmetic textbooks included in their textbooks was what they hoped, and *intended*, students would study; and that what teachers required their students to write in cyphering books constituted the *implemented* arithmetic curricula for those students. Entries in 472 cyphering books—370 prepared in North America and 102 in Great Britain—were examined and it was concluded that, before 1792, a greater proportion of students in British schools studied decimal fractions than in North American schools. That was an unexpected finding given that most eighteenth-century arithmetic textbooks in both nations included sections on both vulgar and decimal fractions. Analysis also revealed that, in the nineteenth century, the proportion of North American students who studied decimal fractions at schools increased but in Great British it did not. The different levels of emphasis on decimal fractions in the two nations are explained through the theoretical lens of lag time.

## Chapter 7: Decimal Fractions and Curriculum Change in School Arithmetic in North America in the Eighteenth and Nineteenth Centuries

**Abstract:** The main purpose of this final chapter is to answer each of the five research questions identified in Chapter 1. In the eighteenth century the British government had transplanted its sterling pounds, shillings, pence and farthings firmly into the British colonies in North America and since the *abbaco* curriculum followed by those who taught school arithmetic was deeply concerned with money calculations, implemented curricula for school arithmetic in North America asked students to perform countless money calculations based on sterling currency. All of that changed after Thomas Jefferson's (1784) successful efforts to introduce a decimalized currency as Federal money, for then the new nation's schools, and teachers were called upon to re-focus their curricula so that new forms of money calculations would be included. However, the new focus was blurred by Congress's decision not to introduce a Federal decimalized system of weights and measures, and the decision to allow the states to continue to use their own versions of sterling money as "legal" currency. As a result, the shift in emphasis resulting from the courageous decision to introduce decimal currency was slow to take hold. The chapter concludes with commentary on the limitations of the study, and with the identification of researchable questions that scholars might profitably address in the future.

# Preface

In 1970 the National Council of Teachers of Mathematics titled its 32nd yearbook *A History of Mathematics Education in the United States and Canada.* Both of the editors of that yearbook—Phillip S. Jones and Arthur F. Coxford—were University of Michigan mathematics professors who had well-documented scholarly interests in mathematics education, including the history of mathematics education.

Jones and Coxford (1970) chose 1821 as the final year of what they identified as the first main period in the history of mathematics education in America. They chose 1821 as the end-point because that was the year Warren Colburn, published his *Arithmetic on the Plan of Pestalozzi with some Improvements* (Colburn, 1821). Colburn's famous text was aimed at teachers of children aged from about 5 or 6 years and, according to Jones and Coxford, its publication marked the first time when mathematics education in America showed concern for pedagogical matters. Jones and Coxford argued that before 1821 the dominant approach to pre-college mathematics education had been through the use of cyphering books in which individual students merely copied and memorized rules, and solved exercises. Jones and Coxford (1970) pointed out that 200 years ago students studying mathematics in American schools rarely owned textbooks—although some of their teachers did own textbooks.

Aside from their unfortunate error of labeling Nathan Daboll, a famous American citizen whose arithmetic textbook was extremely popular between 1800 and 1850, as being English (Jones & Coxford, 1970, p. 45), the 1970 NCTM *Yearbook* did a reasonable job of describing and interpreting mathematics education developments in the United States of America during the nineteenth century. We now know, though, that there was much more to the cyphering tradition than what Jones and Coxford told us in 1970 (see Ellerton & Clements, 2012, 2014).

The subtitle of this present book indicates that the years between 1775 and 1810 have been "neglected" so far as the history of school mathematics in North America is concerned. The subtitle was chosen in order to convey the proposition that something really important happened with respect to mathematics education in North America more than a decade before Colburn's (1821) book was published—and this book investigates that "something."

The "something" we are talking about was the stimulus given to the study of decimal fractions in schools by the introduction of decimal currency as "Federal money" around 1790. Mathematics education research is often characterized as being primarily concerned with investigations into the "teaching and learning of mathematics," but it should be obvious that the quality of mathematics education in a school also depends on the mathematics that students are expected to learn—in other words, the *implemented mathematics curriculum* in that school. In this book we argue, from an analysis of a large data set, that the fillip given to the study of decimal fractions brought about by the introduction of decimal currency *caused* an important change to occur in the type of mathematics that students were asked to learn. We further argue that the architect of the plan to introduce a Federal form of decimal currency, Thomas Jefferson, knew that a decision to mandate decimal currency as the Federal currency would fundamentally change mathematics curricula in schools.

Readers of this Preface may be beginning to think that we are overemphasizing the importance of the impetus given to decimal fractions by the introduction of dollars and cents. To such a point of view we would reply that from our perspective the single most important

development in the history of school mathematics was the creation of the Hindu-Arabic numeration system (including zero), and that the mathematical extension of that system toward the end of the sixteenth century to cover decimal fractions proved to be of great importance to research mathematics, service mathematics, and to school mathematics.

In the seventeenth and eighteenth centuries most authors of school arithmetic textbooks included chapters on decimal fractions—and since arithmetic textbooks written by British authors dominated the school textbook market in the British North American colonies, it has been commonly thought that decimal fractions were widely taught in North America in the seventeenth and eighteenth centuries. In this book we show, by analyzing cyphering-book entries, that before 1790, students in North American schools rarely studied decimal fractions. In other words, the *textbook-author-intended* arithmetic curriculum at the time did not match the *teacher-implemented* mathematics curriculum. That state of affairs gradually changed after the introduction of decimalized Federal money. In Great Britain, however, where no decimal currency was introduced, cyphering-book evidence indicates that even well into the nineteenth century decimal fractions were not much studied in the schools.

At the outset we wish to thank Melissa James and Joseph Quatela, of Springer. Without Melissa's and Joe's generous encouragement, support, and promptings, we would not have been able to complete this venture. We also wish to thank librarians and archivists in the Phillips Library (Peabody Essex Museum, Salem, Massachusetts), the Butler Library (Columbia University, New York), the Clements Library (University of Michigan), the Houghton Library (Harvard University), the American University (Washington, DC), the Wilson Library (University of North Carolina at Chapel Hill), the Special Collections Research Center in the Swem Library at the College of William and Mary and the Rockefeller Library (both in Williamsburg, Virginia), the New York Public Library, Guildhall Library, London, the London Metropolitan Archives, and the Milner Library (Illinois State University) for locating relevant manuscripts, artifacts, and books for us.

We feel honored that Dr Douglas Wilson, who was founding Director of the International Center for Jefferson Studies at Monticello and is presently Co-Director of the Lincoln Studies Center at Knox College in Galesburg, Illinois, agreed to write the Foreword for this book. We want to thank Dr George Seelinger, the Head of the Mathematics Department at Illinois State University (where we both work) for encouraging us in our research endeavors.

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# Chapter 1

# 1776: Dawn of a New Day in School Mathematics in North America

**Abstract:** The 1776 Declaration of Independence announced the dawn of a new day, for North America and, indeed, for the world. But did it herald new a new day for school mathematics? After describing how the term "school" was used in 1776 it is pointed out that at that time only a small proportion of North American adults had studied arithmetic beyond the four operations. The chapter examines the views of Thomas Jefferson on school education, in general, and on school mathematics, in particular. It is argued that it was within Thomas Jefferson's genius that a key to transforming school mathematics in the United States of America would be found.

**Keywords:** 1776; Decimal currency; Declaration of Independence; Education of slaves; Girls and mathematics; History of school mathematics; Metric system; Thomas Jefferson

## A New Day

> We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness—That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed—That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness.

With these words, on July 4, 1776, the former colonies became a new nation. The Declaration marked the dawn of a new day for North America and for the world.

The focus of this book is what school mathematics came to look like in this new world. The words of the Declaration of Independence had a mathematical ring about them—the term "self-evident truth" was obviously to be associated with the concept of an "axiom," and with the geometry of Euclid. This was hardly surprising given that Thomas Jefferson, the young man who had been given the responsibility of drafting the Declaration, would, later in his life, write that when he was young, mathematics had been the "passion" of his life (Thomas Jefferson to William Duane, October 12, 1812).

The majesty of the words in the Declaration masked conflicts among those who would sign the Declaration. "All men were created equal," the statement declared, but in 1776 about 20 percent of the 2.5 million people living in the newly conceived nation were slaves, a station in life which had been forced upon them, often through violent means. Many African-background slaves had been seized, in their African homelands, by slave traders, and had been transported, against their wills and usually in appalling sub-human conditions, across the Atlantic Ocean. Many had died on the way. Given those undeniable events of history, any

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