# Recent Encounters with Abraham Lincoln, Isaac Newton, Nathaniel Bowditch, and Zoltan Dienes

**M. A. (Ken) Clements**
Department of Mathematics
Illinois State University

**Presented to a Meeting of the Australian Mathematical Sciences Institute (AMSI), at the University of Melbourne**

**Friday, July 7, 2017**

# Nerida Ellerton's and my Recent Encounters with Abraham Lincoln, Isaac Newton, Nathaniel Bowditch, and Zoltan Dienes

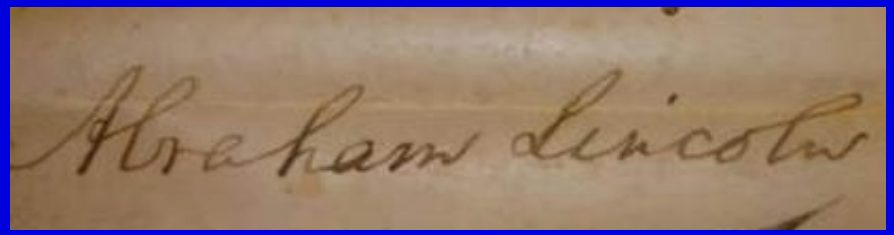
***Abstract:*** **During my time at Illinois State University (2005–2017) I have taken the opportunity to investigate the history of mathematics at all levels, but especially the history of school mathematics. My wife, Nerida Ellerton, and I have spent much time locating and analysing original documents in many excellent archives, including those at Columbia University, Harvard University, Yale University, Cambridge University, Oxford University, the British Library, the New York Public Library, the Library of Congress, and the Maritime Museum (at Greenwich). We have been privileged to "meet" Abraham Lincoln, Isaac Newton, Nathaniel Bowditch, and Zoltan Dienes, and our research has generated five books published by Springer between 2012 and 2017. In this talk I will relate brief stories about our (imaginary) recent encounters with Abraham, Isaac, Nathaniel, and Zoltan, and will then draw some implications for mathematics education, especially in relation to school mathematics.**

# 1. Our Encounter with Abraham Lincoln

**We first met Abraham in 2009, in the Houghton Library at Harvard University. We (Nerida Ellerton and I) located one leaf (2 pages) of mathematics that Abraham had written at school in 1825, when he was 16. These pages, which are part of the oldest extant Lincoln document, had been sitting quietly in the Houghton archives since 1954 (when they were donated to the University), and nobody seemed to know about them. The monetary value of the single leaf today is about $1 million.**

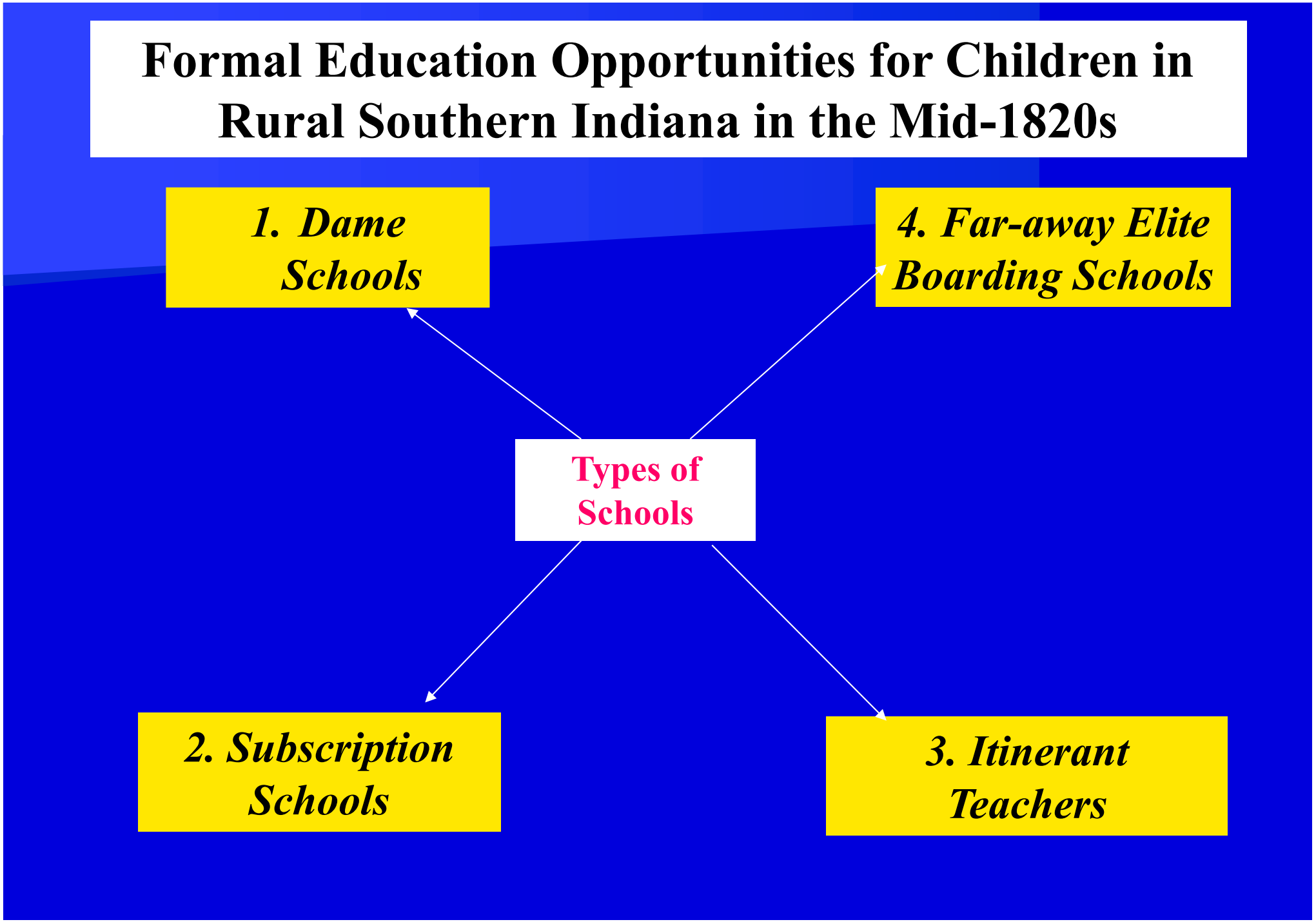
**We had a chat with Abraham, and he gave us permission to talk about his love affair with mathematics. "Don't say too much," he said. I won't.**

**“If any personal description of me is thought desirable, it may be said I am, in height, six feet four inches, nearly; lean in flesh, weighing, on an average, one hundred and eighty pounds; dark complexion, with coarse black hair, and grey eyes—no other marks or brands recollected.”**




1859

# Formal Education Opportunities for Children in Rural Southern Indiana in the Mid-1820s




**Abraham attended five subscription schools between 1815 and 1826.**

# From Abraham Lincoln's Autobiographical Sketch, December 1859 (Note to J. W. Fell)

"My father, at the death of his father, was but six years of age; and he grew up, literally without education—He removed from Kentucky to what is now Spencer county, Indiana, in my eighth year. We reached our new home about the time the State came into the Union. It was a wild region, with many bears and other wild animals still in the woods. There I grew up. There were some schools, so called; but no qualification was ever required of a teacher, beyond the "readin', writin', and cipherin' to the Rule of Three." If a straggler supposed to understand Latin, happened to sojourn in the neighborhood, he was looked upon as a wizzard (*sic*.). There was absolutely nothing to excite ambition for education. Of course when I came of age I did not know much—Still somehow, I could read, write, and cipher to the Rule of Three, but that was all. I have not been to school since."

# What Were Most of the Common Schools and Subscription Schools Like?

**Monroe (1912) and Ellerton and Clements (2012) have claimed that throughout the 18th and early 19th centuries many persons attempting to learn arithmetic never saw a commercially-printed arithmetic. Kennedy and Harlow (1940), maintained that in local one-room schools in Kentucky and Indiana in the early 19th century, the invariably-untrained teacher had to deal with pupils aged from 5 to 25, in a small room with a primitive fire-place, earthen floors, backless benches, no textbooks, little if any spare sheets of paper, a few slates, and no blackboard.**

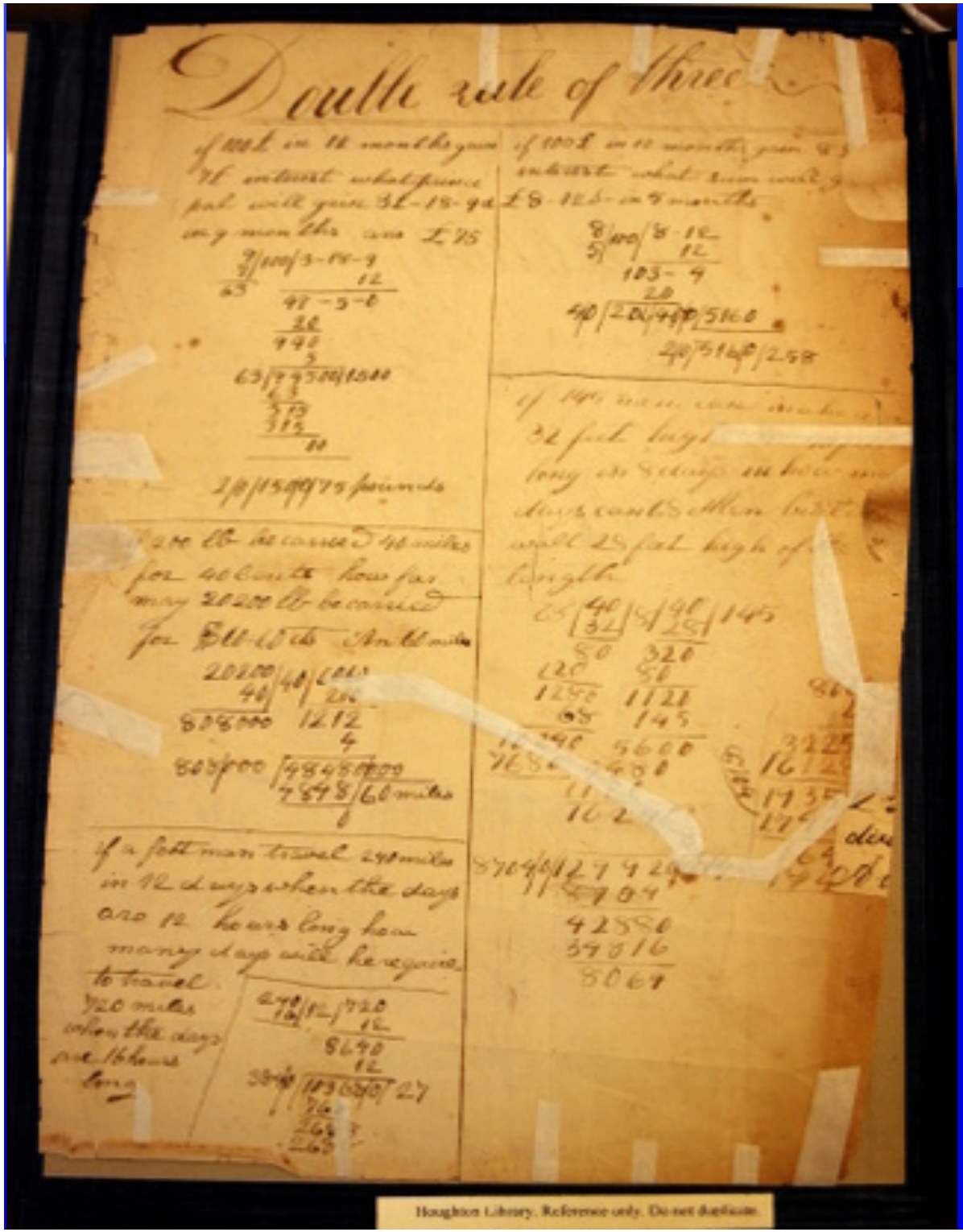
**Samuel Laughlin (1845) recalled that only two of about six of his teachers in remote parts of Tennessee and Virginia between 1805 and 1815 had been able to help him learn arithmetic.**

**In 1838, "Eliza B.," a Massachusetts teacher who received $1.25 per week for the seven-and-a-half-weeks that she taught in a one-room schoolhouse, filed the following report after she had left teaching at the school as a result of being unable to cope with its day-by-day demands:**

**"I am 15 years old. … I wish to say the roof [of the schoolhouse] was all gone in one corner. You can see outside. The windows were all broken but we put paper over them. The floor was gone right under the bad roof. The fireplace does not heat except right in front of it. The wood was very wet at times as there is no woodshed. There are no conveniences for boys or girls. … Children drink from a shared bucket of water, but the school is often so cold that the water freezes. … The big boys took my bell so I could not call them in. Once inside the schoolhouse students made a 'loud noyse' by scratching their slates." (Quoted in Zimmerman, 2009, p. 16)**

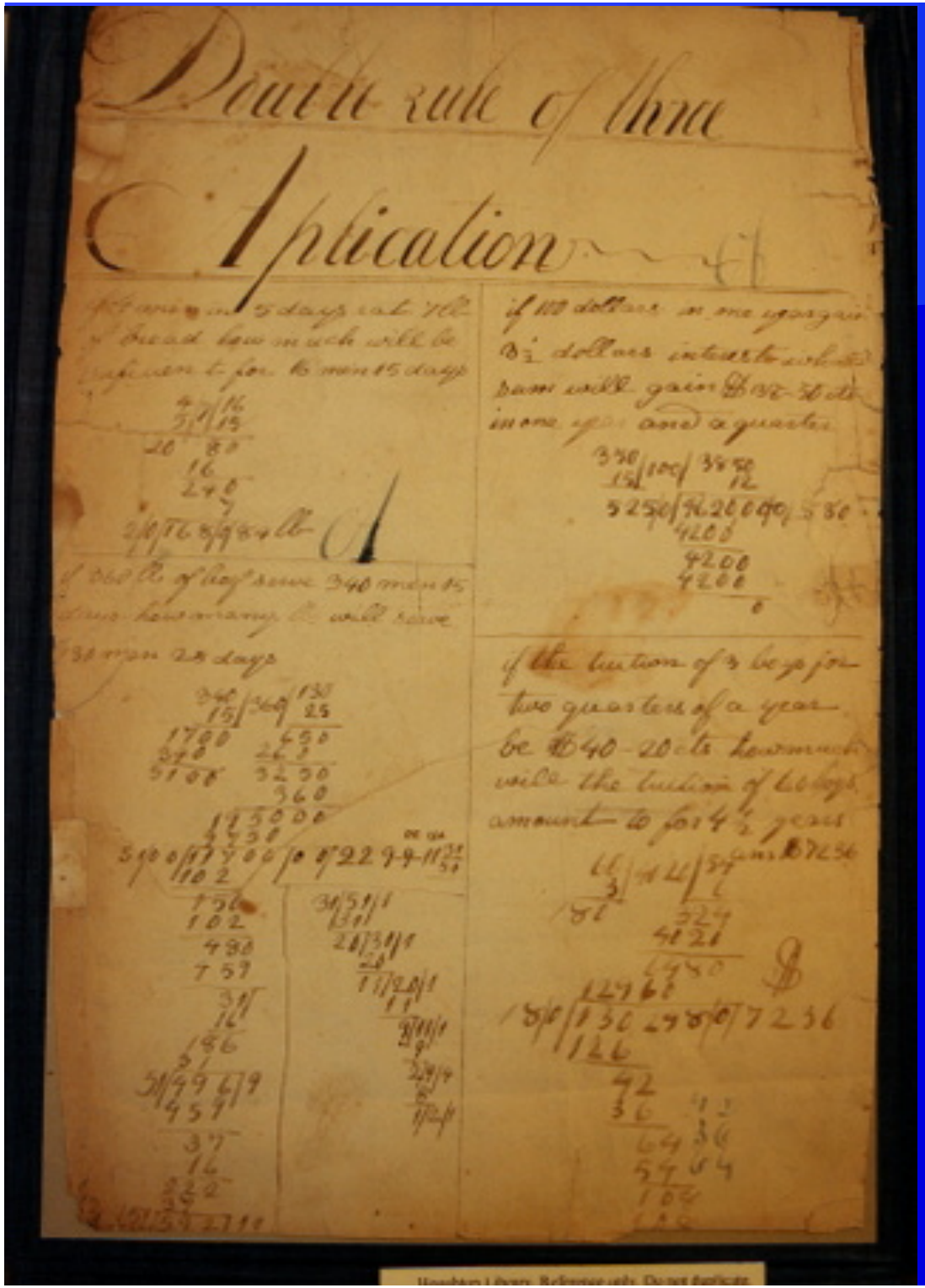
**A reconstruction of one of Lincoln's log-cabin schools—dirt floors, no glass windows, ceiling 6.5 feet from the floor, …**

**… a fireplace but limited light. The outside temperatures were about -5$^{o}$ C. There were, no desks, hardly any writing paper, no textbooks, toilets in the snow!**




**Abraham told us he was delighted we had found this long-lost 30 cm by 20 cm page which he prepared with a quill in 1825 when he was 16. He was then based in rural Southern Indiana.**

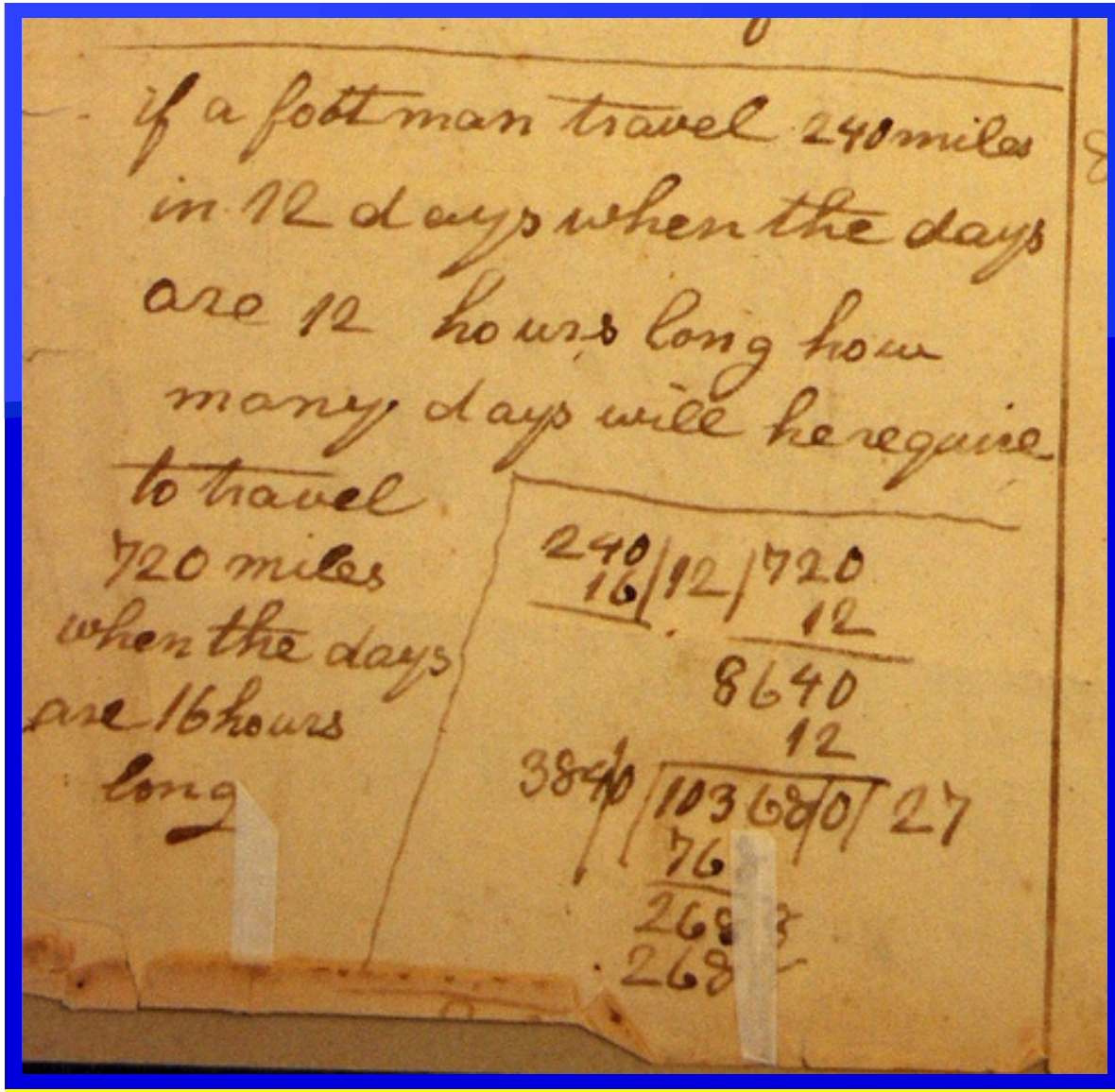
**We didn't tell Abraham, that compared with other cyphering books of 16-year-olds that we have examined (Ellerton & Clements, 2012), the level of his penmanship and calligraphy was only fair.**




Shown is the other side of the leaf from Abraham Lincoln's cyphering book held in the Houghton archives. We didn't tell Abraham, either, that his spelling wasn't particularly good.

"Double Rule of Three" tasks were concerned with compound proportion and were regarded as slightly above elementary arithmetic

Note how Abraham adopted a "Problem-Calculation-Answer" (PCA) genre (Ellerton & Clements, 2012)




**A question identical to that shown is on p. 93 of Thomas Dilworth's (1806) *Arithmetic* and also on p. 84 of Stephen Pike's (1822) *Arithmetic*. Although Dilworth's book was originally published in England in the first half of the 18th century, North American editions of it were still being used in the 1820s.**

**Dilworth's *Arithmetic* was so widely used in the United States that a *Key* to it was written by "a teacher of arithmetic" and published in Brooklyn, New York, in 1812. A *Key* was also published for Stephen Pike's book (McKenney, 1825)**

**In 1948 and 1949 I attended two different one-room schools near Warrnambool, Victoria. My wife's father, Paul Gersch, was a teacher in remote one-room schools in South Australia, and Nerida attended such schools for five or six years.**

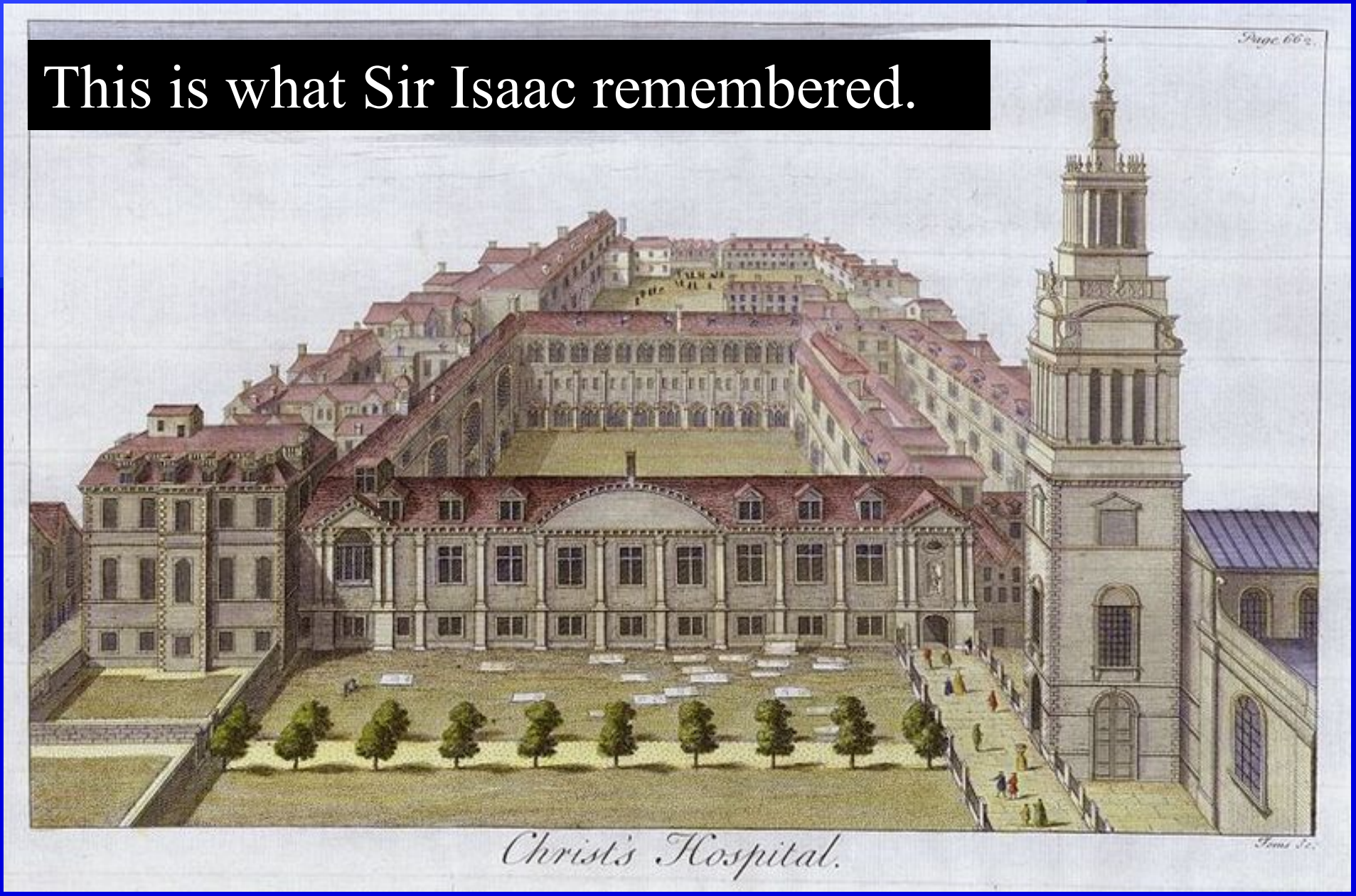
**By comparison with conditions in today's schools, the conditions in the early one-room schools in the United States and in Australia were very challenging. Teachers were not well trained, and had to work under very unfair circumstances—Nerida's father was expected to clean the outside toilets every day, and had to supervise students in the yard for the whole of his lunch period. Inspectors turned up without warning. The teacher had to cope with children aged from 5 to 16. Physical conditions in the schools were often primitive. Most of my 83 first cousins attended one-room schools in the country, and I am the only one who proceeded beyond 9th grade.**

**Was it possible for a young country boy or girl to learn mathematics well under such conditions? Definitely: Abraham Lincoln did, and so did Nathaniel Bowditch. But they were exceptions to the rule.**

Portrait of Isaac Newton, by Godfrey Kneller, 1702 (© National Portrait Gallery, London).

We arranged to meet Sir Isaac Newton at the site of the old Christ's Hospital buildings in central London. When he met him he was extremely disappointed that the old school buildings had gone. "In 1902 the School was relocated to Horsham, 47 miles away", we told him. "What a shame," he exclaimed. "As I remember them, the new buildings in 1705 were magnificent." We agreed, and we showed him the following picture to remind him of the school as he had last seen it. It had housed the world's first secondary-school mathematics program (Ellerton & Clements, 2017).

This is what Sir Isaac remembered.




London (next to St. Paul's), 1705. Christopher Wren was the architect. (Illustration from Ellerton & Clements, 2017, p. 17.)

**We asked Sir Isaac: "Remember when you tried to help Christ's Hospital revise its mathematics curriculum? What did you hope would happen?"**

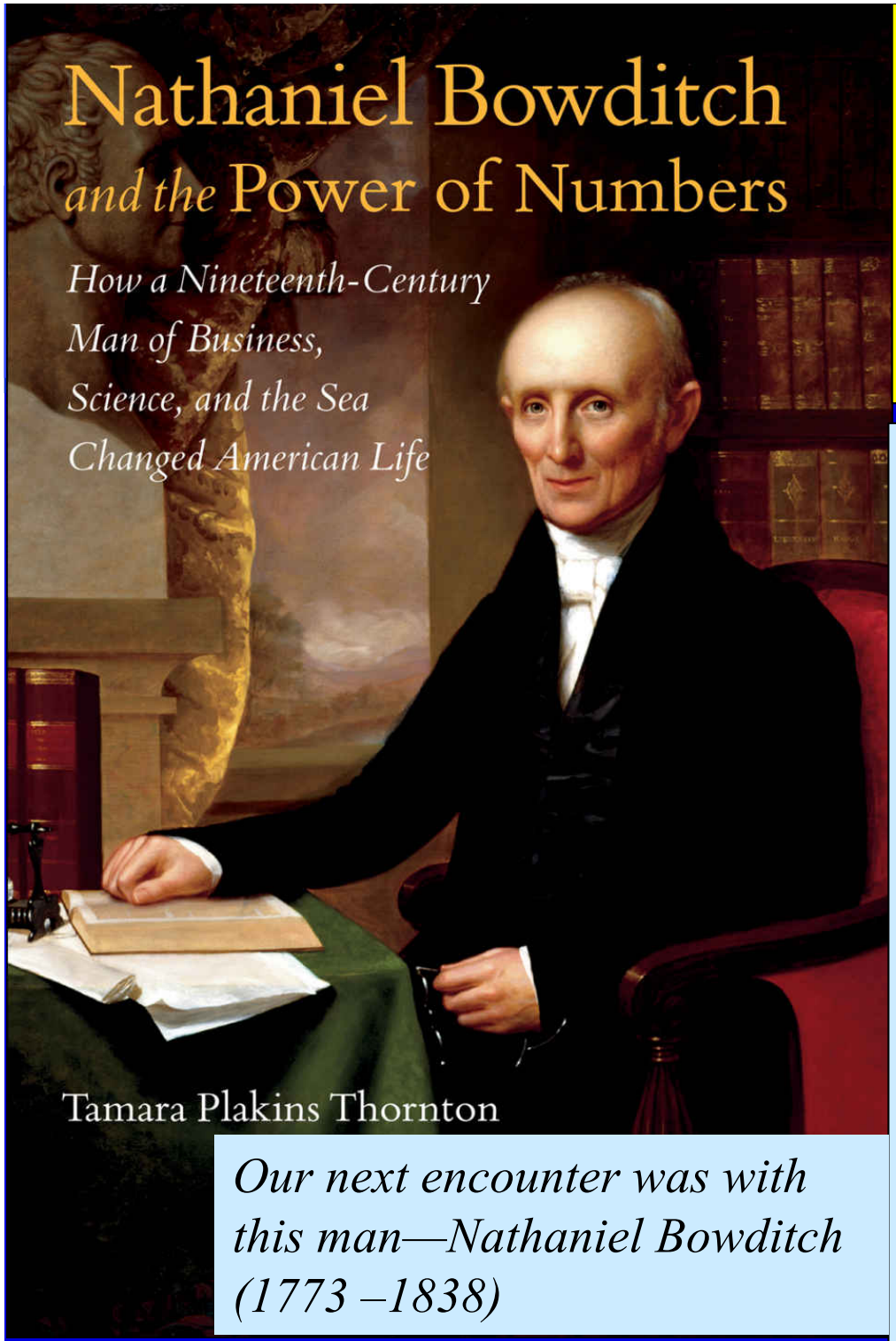
**"Oh yes," he said. "In 1693 the school asked me to develop a new mathematics curriculum for them. I spent a lot of time doing it. It seemed to me that since the curriculum would be for the best young minds in the school, it should cover all the work that I had done with "fluxions"—what you now call calculus—in the 1670s, and also everything I had set out for mechanics in *Principia* in the 1680s. It was important to get the fluxions into the curriculum, because Leibniz, in Germany, was pushing for another ridiculous notation. I wanted the boys at Christ's Hospital to study mechanics because they were going to become navigators. But the school didn't adopt my recommendations".**

# We asked Sir Isaac: "Why didn't Christ's Hospital adopt all of your recommendations?"

"Some of the Governors thought that fluxions and mechanics might be too hard for the boys—I think they were wrong on that because the boys were 15- or 16-years old, and they were the brightest in the school."

"To be honest with you," Sir Isaac told us, "I was a bit annoyed that around 1710 the school decided that the boys should not have to learn mathematics in Latin. How would the boys be able to read the writings of the best European mathematicians, not to mention my own writings, if they couldn't read the books—which were almost always written in Latin? The Governors told me that the boys didn't have enough time to study mathematics in Latin, but I told them they should just keep the boys an extra year at school. It was all very disappointing, given all the time I had put into developing the curriculum for them."

Nerida and I thought: "Wow—he wanted 15- and 16-year-olds to learn calculus and mechanics in Latin!"




*Our next encounter was with this man—Nathaniel Bowditch (1773 –1838)*

**Tamara Thornton's (2016) 416-page *Nathaniel Bowditch and the Power of Numbers*, was published by the University of North Carolina Press. It is one of many books on Bowditch yet, curiously, he is hardly known today.**

**The book captures the feel of the major shipping port of Salem, Massachusetts, during and after the Revolutionary War. By the time Bowditch was 30 in Salem he was the rock star of his time. We first met "Nat" in the Phillips Library in Salem, and we decided to find out more about him. After all, he was the greatest of the early U.S. mathematicians, yet he left school at the age of 10. In 1806 he was offered the chair in Mathematics at Harvard, but turned the offer down!**

# Summary of "Nat" Bowditch's Early Life (from Wikipedia)

1773: Born, in Salem, MA. Son of a former sea captain, who had become an alcoholic, and was now a cooper. "Nat" was the fourth of seven children.

1783: Mother died. Had to leave school at 10, initially to work as a cooper.

1785: Indentured, for 9 years, as a bookkeeping apprentice. He looked after a maritime-related shop. Taught himself algebra, then calculus, then Latin, then French.

1795 Went to sea as ship's clerk. On five trips (to India) he would be clerk, supercargo, and finally captain, and part-owner. Married Elizabeth Boardman in 1798, but she died soon after. Began to read Isaac Newton's *Principia,* and Hamilton Moore's, *The New Practical Navigator* (and, later, Pierre-Simon Laplace's *Mécanique Céleste)*

During his long voyages he corrected many errors in Hamilton Moore's *The New Practical Navigator*, to the point where Edmund Blunt a well-known publisher, decided to publish Bowditch's revised version (*The New American Practical Navigator)* in its own right. "The Bowditch" would became the most widely-used navigation guide in the world. It was issued to new U.S. Navy trainees until the 1960s. In 1800, he married his cousin, Mary Ingersoll, and they had 6 boys and 2 girls.

# Our conversation with "Nat" went something like this.

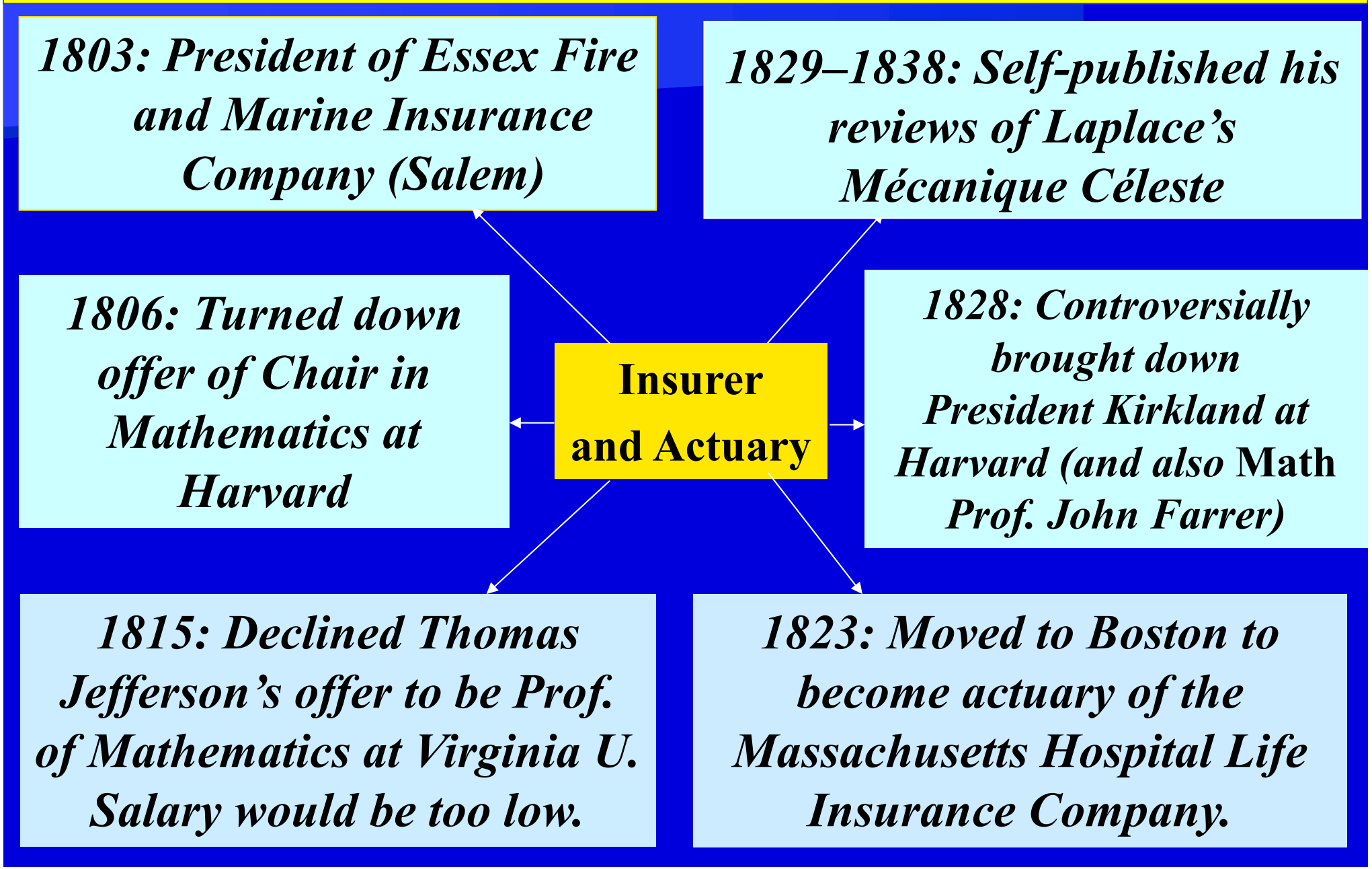
**"Nat, some say you were the greatest navigator the world has ever seen. Why did you give it up so early?"**

**"I wanted to be with my family more. I also wanted to work on Laplace's *Mécanique Céleste* which, for me, was the greatest piece of mathematics written since Newton's *Principia.*"**

**"Tell us, Nat, how is it that you could understand the notoriously complex *Mécanique Céleste*, given that you'd left school at 10?"**

**"I just taught myself. First I taught myself to read French. I guess I was lucky that I was born with a good brain, and with a determination to succeed. I just kept on thinking about Laplace's mathematics until I understood it. I think most bright children in school could learn a lot more mathematics than they do now."**

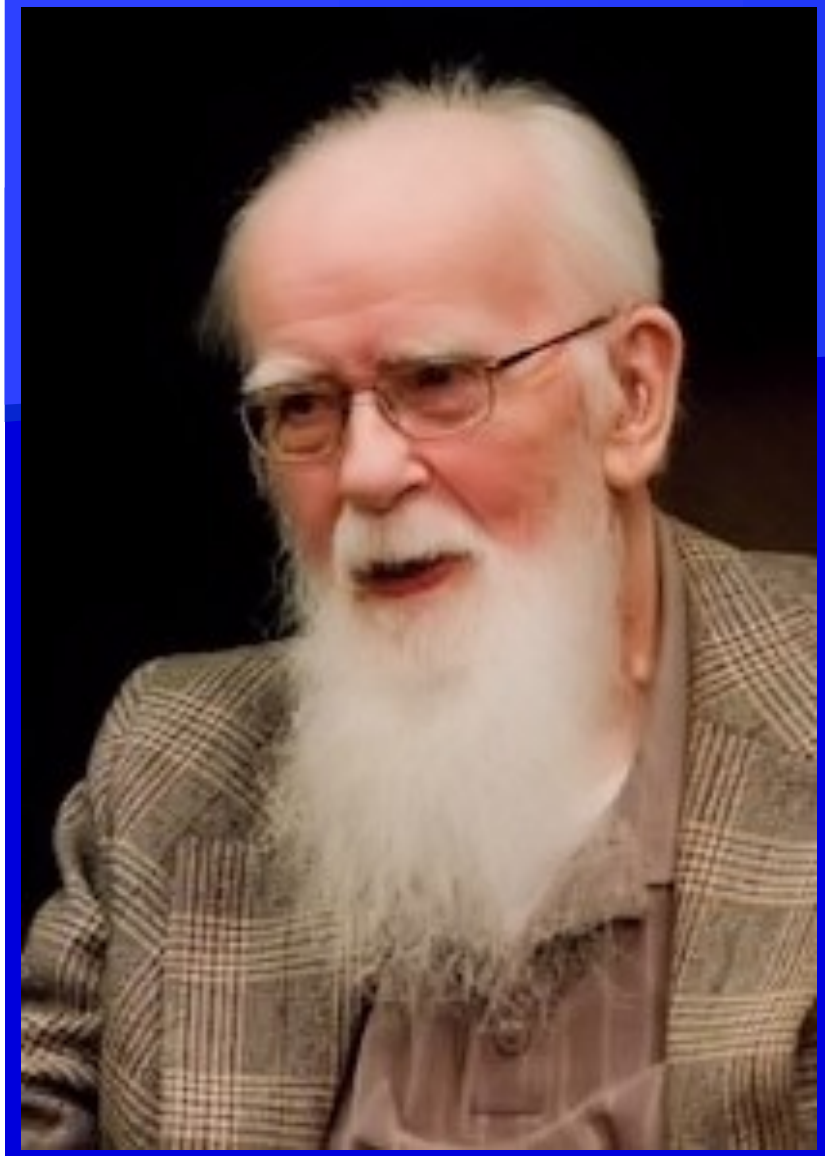
# Nathaniel Bowditch, who left school at 10, takes on Insurance (1803–1838)



# Nathaniel Bowditch's Two Major Mathematical Achievements (among many)

**He wrote *The New American Practical Navigator,* the most successful navigation text in the history of the world. This was first published in 1802 by Edmund M. Blunt's Publishing House. In the 1860s the copyright was taken over by the U.S. Government which, over the next 90 years, would release more than 50 editions of "the Bowditch." Reprints of his book are still sold!**

**He translated and annotated Pierre Laplace's classic *Mécanique Céleste.* Between 1799 and 1825 Laplace proved the dynamical stability of the solar system, and Bowditch not only translated this extraordinarily difficult work, but elaborated on it in great detail. His annotated review occupied four thick volumes.**



**Zoltan Paul Dienes (1916–2014) was originally a mathematician, but he would devote most of his professional life to mathematics education..**

**His major research was reported during the late 1950s, throughout the 1960s, and in the early 1970s.**

**Ref: Sriraman, B. (Ed.). (2008). *Mathematics education and the legacy of Zoltan Paul Dienes.* Charlotte, NC: Information Age Publishing.**

# Zoltan P. Dienes: Three Periods

## 1916–1939

Hungary, France, Austria England, 1932

B.A, PhD. (University of London, 1937, 1939)

Became fluent in numerous languages

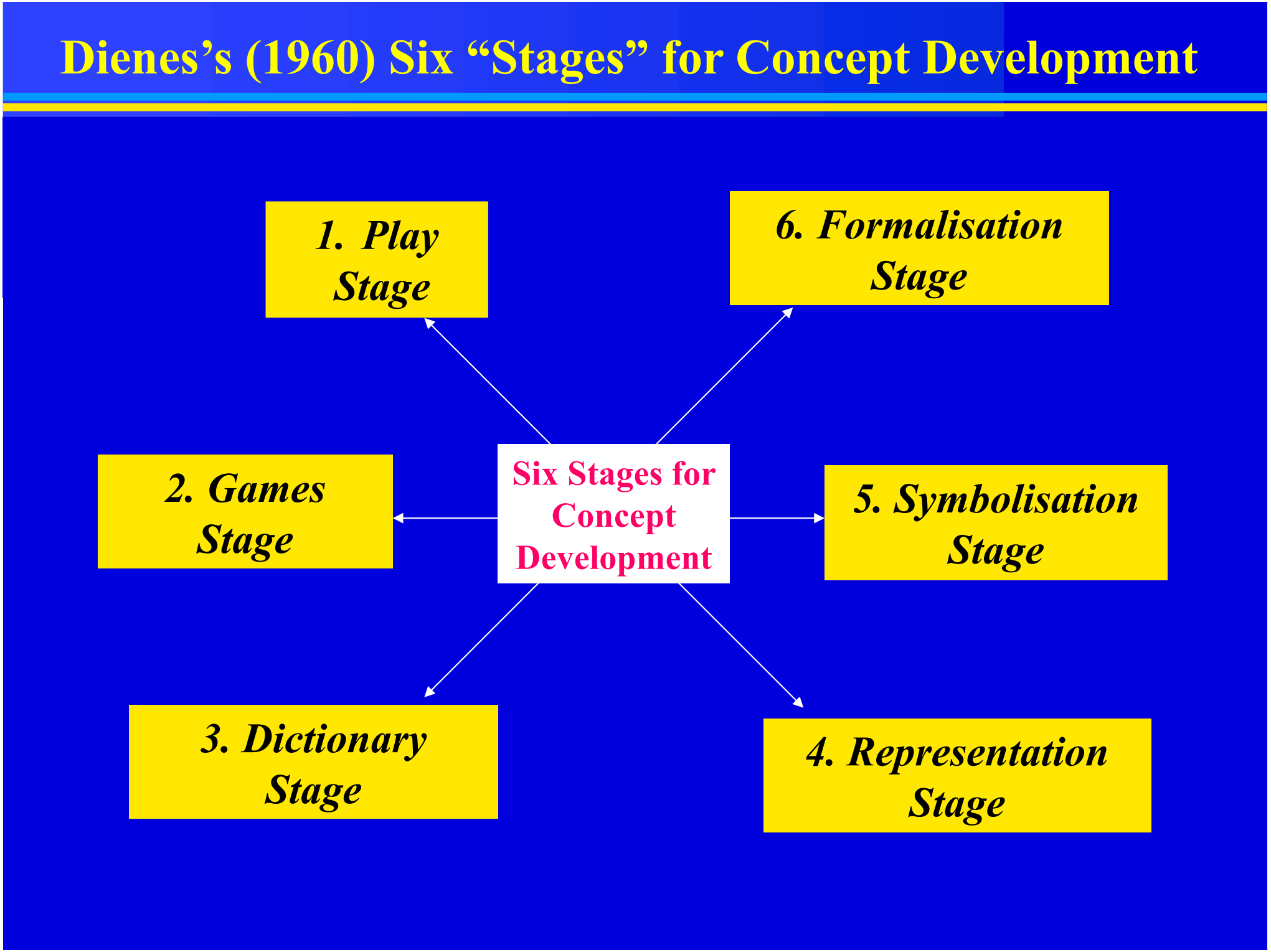
## 1940–1959

- Teacher, mathematician, UK
- *Building Up Mathematics*, MAB, AEM, etc.
- Theoretical base developed and published

## 1960–1978

- Bruner & Harvard (1960)
- Adelaide (1961-1965)
- (UNESCO, IGSML, PNG, wrote books, gave television lessons)
- Sherbrooke (1966-1978)

# Dienes's (1960) Six "Stages" for Concept Development



# Zoltan Paul Dienes worked at the University of Adelaide in the 1960s.

**"Zeddie", as he came to be known, did his PhD *in mathematics* at the University of London in the late 1930s.**

**Two weeks ago (June 2017) I was teaching a graduate class in the Department of Mathematics, at Illinois State University, about the finite group activities (up to order 8, including the quaternion group) which, in the 1960s, Dienes believed primary-school students should study. The graduate students loved his activities, and agreed that they would be suitable for 6th graders. In 1970 I personally saw Dienes successfully teach vector-space concepts to 6-year-olds. He has been called "the 20th-century's mathematics teaching genius".**

**But Dienes' curriculum (which included algebra throughout primary school, and was supported by Jerome Bruner), quickly lost favour in the post-New-Maths era of the 1970s, and in 2017 it is hard to find it being implemented anywhere in the world. What went wrong?**

# So, here's my (imaginary) conversation with Zeddie.

**"Zeddie, in the 1960s you received a lot of government money to introduce your curriculum and teaching approaches into the community schools in Papua New Guinea. It didn't seem to work. What went wrong?"**

**"Well, frankly, the teacher educators didn't do a good job of preparing young teachers for the approach. And, so my curriculum and my approaches were never given a real chance."**

**"But, there are more than 800 languages and indigenous counting systems in PNG, and teachers and teacher-educators there said they didn't understand the sophisticated language you used in your books, or the mathematics that was described. The government spent large amounts of money on equipment to help with the implementation, but no-one seemed to know what to do. Soon after you stopped going to PNG everyone resorted to the traditional curriculum. I've heard that the same sort of thing happened in Adelaide, and in other places."**

**"I think that you're being unduly negative. School mathematics needed to change, and the forces of conservatism stopped progress."**

Another mathematician I knew was Terry Tao, currently Professor at the University of California at Los Angeles, and winner of the Fields Medal. I wrote a paper on Terry (Clements, 1984).

Mrs Grace Tao, Terry Tao, Nigel Tao, Ken Clements (Vinculum editor) and Trevor Tao, when the Taos visited Melbourne. The photograph was taken by Dr Billy Tao.

*inculum. Volume 24. No. 3. SEPTEMBER 1987*

**That photograph was taken in 1986 (3 years after I first met the Taos) when the family visited me in Melbourne. Terence was 7 when I first met him, and brothers Trevor and Nigel were 5 and 3. In the photograph, their ages are 10, 8 and 6. They called me "Uncle McKenzie Alexander." The boys' mother, Grace, shown in the photograph, is very very good at mathematics.**

**In 1983, I lived, and slept, in the Tao household for 10 weeks. You might say, I became a temporary member of the Tao family.**

**Every night, for 10 weeks, in 1983, Grace, 8-year-old Terry, and I solved unfamiliar mathematical problems, together, for two hours (after having watched "Dr Who").**

In October 1980 I had a private lunch with Stephen Hawking, at Cambridge University. Nicholas Warner, whom I had taught mathematics at Yarra Valley Grammar School (in 1973) was, at that time, Hawking's doctoral student. On the same day, I was a special guest for dinner at Trinity College. On the wall, peering down at me (from his portrait), was Sir Isaac Newton. Oh well, it's nice to have "met" such celebrities—but, for me, the principal challenge has been, and remains, that of finding ways and means to help *most* school children learn mathematics well, so that they will come to appreciate its rare beauty.

# References


Clements, M. A. (1984). Terence Tao. *Educational Studies in Mathematics, 15*(2), 213–238

Dienes, Z. P. (1960). *Building up mathematics.* London, United Kingdom: Hutchinson.

Dilworth, T. (1806). *The schoolmasters assistant; being a compendium of arithmetic both practical and theoretical.* New York, NY: G. Jansen.

Ellerton, N. F., & Clements, M. A. (2012). *Rewriting the history of school mathematics in North America 1607–1861. New* York, NY: Springer.

Ellerton, N. F., & Clements, M. A. (2017). *Samuel Pepys, Isaac Newton, James Hodgson and the beginnings of secondary school mathematics: A history of the Royal Mathematics School within Christ's Hospital, London, 1673–1868.* New York, NY: Springer.

Laughlin, S. H. (1845). *A diary of public events and notices of my life and family and my private transactions including travels, readings, correspondence, business, anecdotes, miscellaneous memoranda of men, literature, etc., from January 1st to August 1845, and sketch of my life from infancy.* Library Search Room, Family File, Tennessee State Library. Nashville, TE.

McKenney, F. (1825). *A complete key to the Teacher's Assistant, or System of Practical Arithmetic, compiled by Stephen Pike.* Philadelphia, PA: McCarty & Davis.

Monroe, W. S. (1912). A chapter in the development of arithmetic teaching in the United States. *The Elementary School Teacher, 13*(1), 17–24.

Pike, S. (1822). *The teachers assistant or a system of practical arithmetic; wherein the several rules of that useful science, are illustrated by a variety of examples, a large proportion of which are in Federal money. The whole is designed to abridge the labour of teachers, and to facilitate the instruction of youth.* Philadelphia, PA: Benjamin Warner.

Sriraman, B. (Ed.). (2008). *Mathematics education and the legacy of Zoltan Paul Dienes.* Charlotte, NC: Information Age Publishing.

Thornton, T. (2016) 416-page *Nathaniel Bowditch and the power of numbers*. Chapel Hill, NC: University of North Carolina Press

Zimmerman, J. (2009). *Small wonder: The little red schoolhouse in history and memory.* New Haven, CT: Yale University Press.