5-2017

American Education Reform and the Humanism of Mathematics, 1890-1940

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A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Arts in History from
The College of William and Mary

by

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Accepted for Highest Honors
(Honors, High Honors, Highest Honors)

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Williamsburg, VA
May 3, 2017

Dedicated to Mary McBride, who inspired a love for the history of the Progressive Era.

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Introduction

This thesis is a narrative of the evolution of American mathematics education extending roughly from 1890 to 1940. It is also, more broadly, an exploration of how intellectual communities form and operate, how they come into conflict with other communities, and how these conflicts in turn shape the forms of knowledge that communities produce. Thus, there will be a distinct focus on interdisciplinary connections and points of alignment or tension between communities. To structure this narrative, I will focus on the career and activities of David Eugene Smith, professor of mathematics at Teachers College, Columbia University. Smith makes for a fitting protagonist because he represented a point of convergence for several communities: he was one of America's leading math educators and kept up personal correspondences with many research mathematicians; he was a pioneer in studying the history of math and served as a mentor to young historians of mathematics; and his position at America's foremost school of education put him in contact with other streams of educational thought that were hostile to math. This intellectual milieu led Smith to a peculiar vision of math education that emphasized its humanistic value and its important role in human history.

I have divided the thesis into three chapters, each dealing with a different aspect of Smith's career in roughly chronological order. The first covers the emergence of research mathematics and math education as distinct professions up to the beginning of World War I and sets the stage for later developments. During this period, these two groups developed the professional technologies, above all societies and periodicals, that tied them together into unified national communities. Smith also emerged as one of the central figures in math education, developing a talent for community mobilization and alliance-building that he would use throughout his career. The second chapter, covering the late 1910s and early 1920s, introduces progressive education and its conflict with math as a subject. Progressive educators tried to roll back math requirements in the public high schools, and mathematicians were put in a defensive position in which they were forced to justify the importance of math. The third chapter covers one particular response to the progressive attack: Smith's attempt to redefine mathematics in humanistic terms, as a central facet of human civilization and therefore a central subject in the curriculum. This involved, above all, a push to expand the study of the history of mathematics in America and demonstrate the roles math has played in all dimensions of life throughout human history. These three periods are not a mere chronological progression, but are connected by direct cause and effect: the progressive attack on mathematics provided the motivation to study the history of math, while the earlier professionalization of the subject made Smith's defense of math possible.

A few terms deserve a preliminary explanation. First, "progressive" is a term that is frequently used in to describe changes in American education at the beginning of the twentieth century, but its meaning should not be taken for granted. The term has been problematized in recent histories, as what once appeared to be a unified progressive education movement is today recognized as fractured and heterogeneous. Herbert Kliebard goes so far as to dispense with the term entirely, arguing that it encompasses such a wide range of beliefs that it has become meaningless.[1] However, for the purposes of this thesis it is useful to preserve the label of progressivism in order to contrast the different understandings of what it means to professionalize education. The progressive educators who appear in this thesis, despite their differences, all understood themselves as generalists with expertise in education itself.

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[1] Herbert M. Kliebard, *The Struggle for the American Curriculum, 1893-1958*, 3rd ed. (New York: Routledge Falmer, 2004), xviii-xix.

Mathematicians, on the other hand, tended to see themselves as specialists who cultivated a narrow expertise in their particular subject. These competing notions of educational expertise underlay the conflict between progressive educators and math educators. Second, this thesis makes frequent reference to "professionalization" or "discipline formation" in reference to the growth of various communities. The key to my framework here is the creation of long-term institutions which can preserve the identity and social organization of a community and allow it to continue beyond the careers of its original members. I have not found a concise way to capture this institutionalizing process: professionalization gets at its organizational and identitarian aspects, while discipline-formation highlights its cognitive outlook and identification with a specific object of study.

Two patterns can be identified that will structure this thesis' discussion of community-formation. First, new communities typically began as sub-communities of older groups, incubating within existing institutions before moving into new institutions with a unique identity. The history of math community was an outgrowth of the math education community, which in turn had roots in America's math research community, which was itself rooted in the math research community in Germany. Writing on the social configuration of seventeenth century English science, Steven Shapin claims that "no type of society is wholly new. [...] [T]he social relations and patterns of discourse obtaining within the rooms of the Royal Society were rearrangements and reevaluations of existing models."[2] Likewise, founding members of new communities typically carried with them the expectations and priorities that structured their experiences in older communities. The result of this growth process was a set of communities whose interests and goals typically aligned: math education often served the needs of research

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[2] Steven Shapin, "The House of Experiment in Seventeenth-Century England," in *The Science Studies Reader*, ed. Mario Biagioli (New York: Routledge, 1999), 491.

mathematics, whereas math history was oriented toward the needs of math education. Second, conflict generally deepened the divisions between communities and accelerated the process of self-identification. This can be seen in both the progressive attack, which drew math educators closer together and muted the internal conflicts within the community, and during times when resources were scarce and different math-related communities, whose interests usually aligned, found themselves in competition. The push and pull of alignment and conflict formed a dynamic background in which communities produced knowledge; as such, the shifting alliances of American mathematics are essential to understanding the shapes of the knowledge different communities produced.

I approached this topic from a background in the history of science, and I am particularly indebted to Paul Forman's 1971 work on quantum physics in Weimar Germany.[3] Forman controversially argued that the intellectual environment of 1920s Germany, characterized by anti-rationality and cultural relativism, pushed physicists away from strictly-deterministic Newtonian physics toward the new acausal quantum physics; essentially, physicists capitulated to the demands of a hostile public. Forman here suggests a general model for how intellectual communities interact with their wider culture: when they enjoy a high status in society, intellectuals are free to ignore outside pressures and can think of themselves as aloof and autonomous; but when they come under attack, intellectuals must take action to defend themselves and their field.[4] It is striking that the situations in American math education and in German physics mirrored each other so closely, and this narrative of attack and defense can be usefully applied here. However, I depart from Forman in one important respect: he argues that

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[3] Paul Forman, "Weimar Culture, Causality, and Quantum Theory, 1918-1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment," *Historical Studies in the Physical Sciences* 3 (1971): 1-115.

[4] Forman, "Weimar Culture," 6.

German physicists were "swept up" by broader cultural forces and that they had no choice but to accept outside demands to abandon causality.[5] Instead, I argue that math educators were active participants in negotiating the fate of their subject. They did not simply accept the arguments of outside critics, but instead strove to creatively reinterpret them in ways more amenable to math education. I will frequently describe educators' actions as "strategies" to emphasize their active choice of one option out of several.

This thesis will attempt to fill a gap in the historiography between the disciplines of math education and the history of math. Historians understand that these two fields were closely linked in early-twentieth century America, but their analyses tend to focus on just one and mention the other in passing. For example, writing on the study of the history of mathematics in America, Joseph Dauben notes, without citation, that "by the end of the nineteenth century, the history of mathematics as a useful adjunct to teaching was also recognized"; he takes this as a given through the rest of the text and makes little attempt to explain how the history of math came to be incorporated into an educational context.[6] Writing from the other side, David Lindsay Roberts remarks in passing that prominent math educators took an interest in the field's history, but does not pursue their motivation further as it is not the subject of his text.[7] Parshall and Rowe run into an interesting problem: introducing a work on the growth of American mathematics in the late-nineteenth and early-twentieth centuries, they note that the history of math has been neglected by American scholars in recent decades; yet they give little attention to the study of the history of

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[5] Forman, "Weimar Culture," 3.

[6] Joseph W. Dauben, "United States of America," in *Writing the History of Mathematics: Its Historical Development*, ed. Joseph W. Dauben and Christoph J. Scriba (Basel: Birkhäuser Verlag, 2002), 263.

[7] David Lindsay Roberts, "Mathematics and Pedagogy: Professional Mathematicians and American Educational Reform, 1893-1923" (PhD diss., Johns Hopkins University, 1997), 118n.

math that was emerging during their period of interest.[8] None of these works are centered around the link between the history of math and math education, and so they miss the full significance of the connection: that the history of math as an autonomous discipline emerged precisely because of the peculiarities of the math education scene.

Filling in this historiographical gap leads to important insights regarding the evolution of American math education. By bringing the relationships between different disciplines to the fore, this thesis will denaturalize their development and emphasize the contingency in their relationship. Previous histories tended to take the history of math for granted, seeing it as a resource waiting in reserve that math educators could call upon whenever they needed to add variety to their classes. In fact, the history of math as an intellectual undertaking was built over time in dialogue with the needs of math education; it was actively constructed by mathematicians such as Smith to advance their specific goals. I will argue in this thesis that the expansion in the study of the history of mathematics during the 1920s and 1930s was a direct response to anti-math rhetoric from progressive educators and was designed to present mathematics as a central facet of human civilization.

Finally, it is important to set limits on what can be said in this thesis. This is an intellectual history rather than a social history and thus cannot be a complete picture of early-twentieth century education. Its main characters are a few professors at the top of the educational hierarchy planning what math education ought to look like. Their influence in actual classrooms was limited by the size of America and public education's tendency to change slowly. Moreover, the top-heavy nature of this approach limits the types of individuals who will appear: black Americans are absent entirely, while women, who made up the majority of the country's

[8] Karen Hunger Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1879-1900: J. J. Sylvester, Felix Klein, and E. H. Moore* (Providence: American Mathematical Society, 1994), x-xi.

elementary and high school teachers, play a marginal role. Children and their real experiences in the classroom are only considered from a distance.

Despite these absences, this thesis still has meaningful things to say about history. In contesting how a school subject should be taught, education reformers were making claims about what sort of knowledge is valuable and what sort of person can speak authoritatively on education. These questions have remained relevant up to the present day as educators continue to negotiate, for example, the extent to which vocational preparation should inform high school and university education. At a time when mathematics routinely ranks well in lists of highest-earning college majors, it is jarring to consider a past in which the subject was widely dismissed for its uselessness in most people's lives. By revisiting this moment and tracing the arguments of math's supporters and detractors, this thesis reveals the plasticity of a subject's perceived usefulness and the dangers of tying a subject's worth to its vocational applicability.

The Formation of an American Mathematics Education Community

It should come as no surprise that the United States of the mid-nineteenth century was not a powerhouse of mathematical research. That era's great developments in non-Euclidean geometry and set theory were pioneered in Europe. The few Americans who did make contributions to mathematics tended to work in applied fields, especially astronomy, while the cutting edge of European mathematics was increasingly abstract and foundational. This situation began to change at the end of the century, when more and more Americans looked toward developments in Europe and chose to specialize in new fields such as complex analysis or abstract algebra. This turn from applied to pure mathematics was accompanied by an increasing sense that mathematics itself was a profession: that it was distinct from astronomy or physics or engineering and that all professional mathematicians in America were working together on a shared project of knowledge acquisition. This sense of shared identity was expressed by the proliferation of societies and periodicals that marked a mathematician's membership in the community. The interactions within this community in the form of public addresses and private correspondences provide the modern historian with important evidence on its structure, motivation, and conflicts.

This chapter will explore this process of mathematical community-building and the pedagogical questions that emerged from it. In this environment, research mathematicians became concerned with the teaching of lower-level math for several reasons. Some saw a need to bring the standards of modern abstract math to the schools to prepare the next generation for the rigor and precision needed to do research mathematics. Others took a more catholic approach, broadening the focus of math education to make it more amenable to related (or rival) fields such as physics or engineering. By the early 1910s, David Eugene Smith's school of thought had become the dominant voice in the reform conversation by positioning itself as a moderate alternative to more radical forms of reformism. This situation was cemented with Smith's major role in the International Commission on the Teaching of Mathematics, which was simultaneously a confirmation of the organizational abilities of American math educators and the definitive statement of purpose for math education reformers before World War I. Smith succeeded in building a degree of consensus around his vision of reform because of his exceptional skill at navigating community networks, using the social tools of the professional class to bring allies to his side.

The Professionalization of American Mathematics

The American mathematics community began with personal relationships and informal groups which served as the starting point for the official infrastructure of societies or periodicals. While it is impossible to name a definitive moment when this community-forming process began, Felix Klein, professor of mathematics at the University of Göttingen in Germany, serves as a useful starting point. While the early phase of his career saw Klein make major contributions to geometry and group theory, by the 1880s he had turned his attention to training a new generation of mathematics researchers to fill in the details of the work he had begun. By coincidence, Klein dedicated himself to a mentoring role at a moment when young American mathematicians, lacking research opportunities at home, increasingly received their doctorates abroad. Despite the language barrier, Germany was an obvious choice due to its abundance of research universities; within Germany, Göttingen had a prestigious mathematical heritage that included Gauss, Dirichlet, and Riemann.[1] Returning to the United States, these mathematicians took up university positions, especially at young western universities such as Michigan, Wisconsin, and California, where they established a domestic mathematical presence and made studying abroad unnecessary.

The next several decades saw a new phase in the growth of the mathematics community, with a proliferation of professional societies and journals. In 1887, the Columbia University student Thomas Scott Fiske traveled to Cambridge to attend a meeting of the London Mathematical Society. On his return, he founded the New York Mathematical Society, believing that American mathematicians would benefit from the closer communication and cooperation he witnessed in England.[2] Within a few years, the organization would extend its scope nationally and rename itself the American Mathematical Society (AMS).[3] The AMS has served as a center of pure mathematics research from the 1890s until the present, but by the 1910s some of its members felt a need for the organization to deal explicitly with educational issues. The leaders of the AMS were hesitant to expand the organization's scope but endorsed the creation of a new society focused explicitly on teaching; in 1915, the Chicago mathematician Herbert Slaught founded the Mathematical Association of America (MAA), dedicated to improving the teaching of college-level math.[4] One final split took place soon after: in 1920, a group of Chicago math teachers organized the National Council of Teachers of Mathematics (NCTM), focusing on the question of high school mathematics and its defense from hostile anti-math educators (discussed

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[1] Karen Hunger Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1879-1900: J. J. Sylvester, Felix Klein, and E. H. Moore* (Providence: American Mathematical Society, 1994), 186-187. These authors estimate that by 1904, 20% of AMS members had studied in Germany.

[2] Raymond C. Archibald, *A Semicentennial History of the American Mathematical Society, 1888-1938* (New York: American Mathematical Society, 1938), 4.

[3] Parshall and Rowe, *Research Community*, 403.

[4] Parshall and Rowe, *Research Community*, 419.

in the next chapter).[5] Over the early decades of the twentieth century, then, mathematicians and math teachers moved from personal and regional connections to national communal networks, subdivided to address specific issues. This professional infrastructure formed the background in which debates over math education took place.

It is no coincidence that Chicago was at the center of these developments. Eliakim Hastings Moore, chair of the University of Chicago's mathematics department, is credited both today and in his own time as a pioneer of pure mathematics research in America. Moore came to Chicago in 1891, just a year after the university's founding, intending to build a math department focused on graduate study and original research.[6] He accomplished this surprisingly quickly, demanding advanced coursework from students and publishing papers on Galois fields, an active area of mathematical research, as early as 1892.[7] An American university had finally caught up to the Europeans and made original contributions to abstract mathematics. Moore proceeded to host the Chicago Mathematics Congress in 1893 (held in conjunction with that year's World Fair), which featured papers read by leading German mathematicians such as Klein, David Hilbert, and Hermann Minkowski and boosted the Midwest's reputation for mathematical research.[8] While American mathematics of the 1880s had been dominated by travel abroad to Göttingen, the 1890s saw the establishment of a domestic community of professionals that would continue to grow over the following decades.

[5] David Lindsay Roberts, "Mathematics and Pedagogy: Professional Mathematicians and American Educational Reform, 1893-1923" (PhD diss., Johns Hopkins University, 1997), 364-7.
[6] Parshall and Rowe, *Research Community*, 284.
[7] Parshall and Rowe, *Research Community*, 378.
[8] Parshall and Rowe, *Research Community*, 328-330.

Two Approaches to Math Education

On top of these major contributions to research mathematics, Moore took an unusual interest in lower mathematics and put forward a unique program of math education. In a 1902 address commemorating his retirement as AMS president, Moore presented a new model of math education at all levels of instruction.[9] This was a landmark event for math education, with the country's foremost research mathematician advocating an abandonment of the formalism of nineteenth century math education in favor of a radically empirical approach. The debate between formalism and empiricism would dominate math education for the next decade. However, Moore's entry into the pedagogical conversation was also significant in defining how research math and math education could relate to one another. His speech was framed as an arrangement that would serve the interests of pure mathematics; those that opposed his program often did so in similarly research-oriented terms. Professional math education thus came to define itself in relation to the existing research mathematics enterprise.

While math education in the nineteenth century was not a static institution, there are a few broad generalizations that can be drawn to establish what reformers were rebelling against. A public-school math education consisted of arithmetic, algebra, and geometry, usually taught in that order. Trigonometry was occasionally taught at the end of high school; calculus was confined to the universities. Arithmetic dominated the math curriculum, taking up the first seven years of school at least.[10] The textbooks for all of these subjects tended to rely on logical definitions and rules for students to memorize. A popular arithmetic textbook, for example, introduced addition as "the process of finding a number that expresses as many units as the

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[9] E. H. Moore, "On the Foundations of Mathematics," in *National Council of Teachers of Mathematics Yearbook* 1 (1926): 32-57. This NCTM yearbook was subtitled "A General Survey of Progress in the Last Twenty-Five Years," and the inclusion of Moore's 1902 speech indicates its reputation as a catalyst for educational progress.
[10] Florian Cajori, *The Teaching and History of Mathematics in the United States* (Washington: Government Printing Office, 1890), 294-295.

numbers to be added contain" before explaining the rules of carrying sums to the next decimal place and launching into practice problems.[11] The traditional geometry text for hundreds of years had been Euclid's *Elements*; by the end of the nineteenth century this had been replaced by modern geometry textbooks that still followed Euclid's basic structure, beginning with basic definitions and axioms and spending the rest of the text working through proofs.[12] These features of nineteenth century math textbooks reinforced the subject's reputation for dry mechanicalism and abstraction.

Moore's speech defined itself against this state of affairs. After a brief discussion of recent developments in abstract math by Europeans such as Peano, Hilbert, and Poincaré, (demonstrating America's newfound awareness of cutting-edge foundational research), Moore took an unexpected turn, asking whether mathematicians risked losing sight of the broader intellectual world while making these important advances. He warned his audience that a "chasm" had opened between pure and applied math, with the result that purely research-focused math teachers were not able to prepare physicists or chemists for their future careers.[13] The AMS was dedicated purely to mathematical research (and would indeed use this argument to avoid getting involved in educational matters a decade later), yet through his speech Moore argued that mathematicians should shift the focus of education away from abstraction and toward concrete applications of math—precisely the opposite of the previous decade's trend at Chicago. Moore did not see this as a tension, and in fact believed that it would strengthen math research in the long run: by moving elementary and high school mathematics away from the strict logic of proofs and toward the (presumably) more interesting domain of applications, teachers could make math class more engaging for students and inspire more young people to pursue higher

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[11] Silas L. Loomis, *Normal Arithmetic, Part I* (Philadelphia: J. B. Lippincott & Co., 1859), 22.
[12] For example, G. A. Wentworth, *Plane Geometry*, rev. ed. (Boston: Ginn & Co., 1899).
[13] Moore, "Foundations," 39.

mathematics as a career. Moore's speech raised questions on the importance of student interest and the relative value of abstract and concrete work that would remain contested for the next decade and beyond.

The solution Moore proposed against this chasm was the so-called "laboratory method," which would serve as a common educational base for future research mathematicians, scientists, and engineers. Math teachers could overcome this disciplinary split through what Moore called "indirection:" "arranging the curriculum so that throughout the domain of elementary mathematics the branching [of pure and applied mathematics] be not recognized."[14] One might think that these two paths, emphasizing either deductive proofs or specific applications, would require different educations, but Moore disagreed: while he admitted that the final product of research mathematics was the deductive proof, he argued that the process of doing mathematical research relied on the intuition and hypothesizing of inductive reasoning.[15] Thus, a math education that stressed creativity and provisional guesswork could serve the needs of all students better than one built around memorizing proofs and abstract rules. His suggestion for teaching geometry exemplifies this thinking: rather than follow or memorize the 2000-year old axioms and proofs of Euclid, each student would propose his or her own sets of axioms, see what knowledge can be rigorously derived from them, and compare the results with other students.[16] Moore saw this class environment as "thoroughly practical and at the same time thoroughly scientific," broadening the usefulness of math education without sacrificing its potential for pure research.[17]

[14] Moore, "Foundations," 45.
[15] Moore, "Foundations," 37.
[16] Moore, "Foundations," 48.
[17] Moore, "Foundations," 48.

Several influences on Moore's thought can be identified that place him in the context of an international revolt against formalism. In broad terms, the late nineteenth century saw the natural sciences gain prestige and demand a place in the school curriculum. British intellectuals such as T. H. Huxley and Herbert Spencer argued that the best way to prepare children for adult life was to teach inductive scientific reasoning as the correct way to gain knowledge from their environment; deductive mathematics, by contrast, was an abstract closed system that only prepared students to jump through more logical hoops.[18] Faced with this challenge to abstract deduction, Moore's response was to adopt its reasoning and emphasize the "scientific" aspects of mathematics; the name "laboratory method" was a clear acknowledgement of this widespread faith in science. Another important influence was, unsurprisingly given his important place in American mathematics, Felix Klein. Only a few years before Moore, Klein had raised similar concerns about the fragmentation of modern math—that it threatened "to sacrifice its earlier unity and to split into diverse branches."[19] Moore adopted Klein's philosophical position and cited his approach to education in Germany approvingly.[20] Finally there was the Englishman John Perry, a professor of engineering who believed that his country's heavy focus on deductive proofs did not serve the needs of his students and who succeeded in removing Euclid from England's secondary school curriculum in 1901.[21] Perry was especially fond of visual representations of mathematical concepts and advocated the use of squared paper ("graph paper," in modern usage) as a teaching tool; he also argued that students should be encouraged to find the area and perimeter of geometric shapes via string and squared paper, rather than by formula

[18] Lawrence Cremin, *The Transformation of the School: Progressivism in American Education, 1876-1957* (New York: Alfred A. Knopf, 1962), 91-92.
[19] Felix Klein, "The Present State of Mathematics," in *Mathematical Papers Read at the International Mathematical Congress Held in Conjunction with the World's Columbian Exposition Chicago 1893*, ed. Moore et al. (New York: Macmillan & Co., 1896), 133.
[20] Moore, "Foundations," 39.
[21] Roberts, "Mathematics and Pedagogy," 282.

or proof.[22] Moore agreed with this visual, hands-on approach, adding that "all results should be checked, if only qualitatively or if only 'to the first significant figure'"—another attempt to inject scientific thinking into math education.[23] Just as Moore the research mathematician looked to the European achievements of Peano and Poincaré, Moore the educational theorist looked to European reformers such as Klein and Perry.

Moore, however, was a research mathematician first and an education reformer second. After 1902, his interest in teaching gradually declined, leaving it to younger mathematicians at the University of Chicago to continue his reform program. One good example was Jacob William Albert Young, who continued writing on pedagogy into the 1920s.[24] Young had joined the Chicago faculty in the 1890s with the intention of researching new topics in group theory, but by 1896 Moore had recognized that the younger mathematician's talent was in pedagogy rather than pure research.[25] Young's primary statement of pedagogical thought came in 1906 with the publication of *The Teaching of Mathematics in the Elementary and Secondary School*, which ran for three editions through 1924.[26] Young's lengthy treatment of the laboratory method borrowed heavily from Moore, fleshing out ideas as necessary: he claimed that different areas of mathematics should be taught together, rather than in separate "water-tight compartments;" teaching should move from concrete examples to abstract principles and should not get bogged down in precise definitions too early; different methods of proof, such as intuition and measurement, should be accepted in addition to classical deduction; and graphical teaching tools

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[22] John Perry, "The Teaching of Mathematics," in *Discussion on the Teaching of Mathematics*, ed. John Perry (London: Macmillan & Co., 1902), 27-8, 26.
[23] Moore, "Foundations," 50. Quotation in original.
[24] J. W. A. Young should not be confused with J. W. Young, an unrelated math educator from the same period. "Young" will refer to J. W. A. for the entirety of this chapter.
[25] Quoted in Roberts, "Mathematics and Pedagogy," 221-2.
[26] Roberts, "Mathematics and Pedagogy," 315.

should be emphasized to the point of "canonizing" squared paper.[27] Chicago faculty members such as Young thus ensured that Moore's laboratory method remained a part of educational conversations even after Moore's attention shifted elsewhere.

This reform program, originating from and concentrated in the Midwest, was opposed by East Coast mathematicians such as William Fogg Osgood who were less open to alternative teaching methods. Osgood studied under Klein in the 1880s, like so many mathematicians of his generation, before taking a position at Harvard in 1890; unlike Moore, however, Osgood did not integrate Klein's interest in the unity of pure and applied mathematics into his teaching approach.[28] Osgood was a devoted research mathematician and believed that the primary purpose of math teaching should be to prepare mathematicians, not engineers or scientists. The proper direction of education, then, should not be toward loose definitions and intuition, as Moore and Perry argued, but toward more rigorous logic and exact language. Osgood served as AMS president, like Moore, and used his own presidential address of 1907 to outline pedagogical ideas, this time focusing on university-level calculus.[29] Osgood admitted that nineteenth-century math education had perhaps been too dry and heavy on memorization, but countered that "recently the pendulum has swung to the other extreme," and warned his colleagues not to forget that "the process by which the youth actually acquires the ideas of the calculus is to a large extent and essentially through formal work of substantial character."[30] Graphs and applications might be useful in building students' interest in the subject, but the only way to learn calculus is to *do* calculus, which is by nature difficult and abstract. Rather than using real-world examples

[27] J. W. A. Young, *The Teaching of Mathematics in the Elementary and the Secondary School* (New York: Longmans, Green, & Co., 1906), 97-114.
[28] Parshall and Rowe, *Research Community*, 204.
[29] William F. Osgood, "The Calculus in Our Colleges and Technical Schools," *Bulletin of the American Mathematical Society* 13 (1907): 449-467. It is characteristic of Osgood's focus on research that he did not venture below calculus into more elementary areas of math.
[30] Osgood, "Calculus," 450.

as a way to build intuition for abstract math, Osgood thought that physical situations could only truly make sense after studying the mathematics underlying them; for example, before attempting to calculate the projectile motion of a golf ball, Osgood urged teachers to cover "many, many simple quantitative problems" so that students understand the mathematics of motion.[31] This approach to education was incompatible with the laboratory method's looser standards for proofs and sensitivity to students' interest.

Osgood is sometimes called a "conservative" due to his rejection of the Chicago reform program, but this label is imperfect.[32] First of all, it is important to remember that modern abstract mathematics itself was new to America in the early twentieth century, and in this sense Osgood was on the cutting edge of mathematical research. Osgood recognized the low quality of basic math teaching in America and took part in efforts to improve teacher training, going beyond his duties as a university professor. He was involved in the founding of the Association of Teachers of Mathematics in New England, the objectives of which included making teaching "more effective and more closely related to practical affairs" and to improve the quality of teacher training.[33] Osgood's calculus textbook, first published in 1907, is good evidence of his refusal to remain complacent with regard to the quality of teaching.[34] This text was praised by reviewers as an improvement over earlier works and for being, despite its rigor, easily

[31] Osgood, "Calculus," 450. By modern standards, a projectile motion problem would be considered appropriate for physics students within the first few weeks of an introductory course.
[32] See, for example, Roberts, "Mathematics and Pedagogy," 329.
[33] "Twenty Years of the Association of Teachers of Mathematics in New England," *Mathematics Teacher* 17 (1924): 95. The article is vague as to the meaning of "practical affairs," but mentions the association's interest in the mathematics involved in modern industry.
[34] William F. Osgood, *A First Course in the Differential and Integral Calculus* (New York: Macmillan Company, 1907).

understandable.[35] Nevertheless, it is clear that Osgood represented an opposite pole of math education compared to Moore or Young. While the Chicago reformers wanted math education to begin with concrete problems before moving to abstract principles, Osgood wanted to preserve math education's traditional focus on logical deduction, bringing it up to modern mathematics' standards of rigor when necessary. This view might be called "conservative," given its closer ties to nineteenth century education, but it was still a departure from the past; "formalist" is a more politically neutral label that will be used here.

This debate of the first decade of the twentieth century, perhaps unintuitively, is evidence of the cohesion and strength of a growing math education community. It took place at a few discrete sites of professional deliberation, notably AMS addresses and textbooks, which kept the debate within the bounds of professional goodwill. The differences between Osgood's and Moore's educational programs were clear, yet the two professors recognized each other as members of the same community who could deliberate constructively. Furthermore, education reformers on both sides engaged with the contemporary intellectual milieu, abandoning the parochialism common in stereotypes of nineteenth century American education. While most of the relevant actors in this conversation were research mathematicians, they succeeded in setting the terms and objectives that math educators would use to define themselves.

The Early Career of David Eugene Smith

While these two factions were debating the proper course for math education, David Eugene Smith was emerging as one of the most well-known math educators in the country. Smith's career path was different from the reformers considered thus far: he spent his

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[35] For example: Cassius Keyser's review in *Science* 27 (1908): 954-957; G. H. Hardy's review in *Mathematical Gazette* 4 (1908): 307-309; and H. J. Ettlinger's review of a later edition in *American Mathematical Monthly* 8 (1923): 444-446.

professional life teaching in a series of normal schools in New York and Michigan, culminating with his appointment to Teacher's College in 1901.[36] While Moore, Klein, and Osgood were research mathematicians who happened to take an interest in teaching, Smith was a lifelong educator by profession and was much closer to the on-the-ground realities of the elementary and high school. This professional allegiance to schoolteachers is visible throughout Smith's writings on the math reform movement. Writing retrospectively, he attributed the successes of reforms to teachers themselves, not to abstract pedagogical theorists: "it is always a case of her [the teacher's] common sense against unusable theories and against experiments that are foredoomed to failure. She has been little disturbed by the preaching of false prophets."[37] Despite his high intellectual convictions and his support for more and better teacher training, Smith tended to espouse common sense over pedagogical experiments thought up by those without experience teaching elementary mathematics. This democratic faith in the reasonableness of ordinary people contrasted with the tone of expertise used by researchers such as Osgood or Young and designated Smith as a moderate between two "extreme" positions.

This attitude is visible in the series of textbooks Smith authored in the 1890s and 1900s that first brought him recognition within the education community. His first work, coauthored with W. W. Beman in 1896, sought to "invest the ancient geometry with something of the spirit of modern mathematics."[38] This vague goal was, in fact, shared by almost everyone concerned with math teaching: Moore and Young wanted to modernize teaching in the sense of making it more scientific and application-oriented, while Osgood wanted to bring the rigor of modern abstract mathematics to lower levels of teaching. However, the balancing of "ancient" and

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[36] William D. Reeve, "Editorial," *Mathematics Teacher* 37 (1944): 278

[37] David E. Smith, *The Progress of Arithmetic in the Last Quarter of a Century* (Boston: Ginn & Co., 1923), 3.

[38] W. W. Beman and David E. Smith, *Plane and Solid Geometry* (Boston: Ginn & Co., 1896), iii. The Beman and Smith text is, overall, fairly traditional, being heavy on formal definitions and abstract practice problems. This is unsurprising, given how early the text was published.

"modern" is characteristic of Smith's writing style and teaching goals, especially as they relate to his interest in history (discussed momentarily). His next arithmetic textbook of 1904 embraced new teaching ideas more explicitly, while preserving his restraint and aversion to extremes. The *Primary Arithmetic,* intended for use over the first half of elementary school, was organized according to a new "spiral arrangement:" rather than covering a given topic in its entirety and then moving onto the next, Smith returned to topics several times over the book, each time incorporating larger numbers and more difficult problems. The first chapter covered the basic operations using numbers up to twelve, the next covered the numbers up to 100, then up to 1,000, and so on.[39] This was intended to more naturally follow children's mental development and avoid forcing complex tasks on them too soon. However, Smith also called the spiral arrangement "unscientific and uninteresting" when taken to its extreme, again demonstrating his commitment to moderate reformism.[40] Smith's last textbook work before World War I was a series of collaborations with George Wentworth covering arithmetic, algebra, geometry, and vocational mathematics.[41] This choice of coauthor is intriguing: Wentworth was a popular textbook author at the end of the nineteenth century and was recognized in 1890 as one of the most widely-used math textbooks in America, symbolizing the best of math education in the generation immediately preceding Smith.[42] The two authors' collaboration is itself evidence of Smith's desire to advance math teaching while preserving a sense of historical continuity.[43] Early

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[39] David Eugene Smith, *Primary Arithmetic* (Boston: Ginn & Co., 1904), v-vii.
[40] Smith, *Primary Arithmetic*, iv.
[41] George Wentworth and David Eugene Smith, *Wentworth-Smith Mathematical Series* (Boston: Ginn & Co., 1911). Looking through Smith's papers does not reveal when or how Smith and Wentworth met.
[42] Florian Cajori, *Mathematics in the United States*, 294. Wentworth's textbooks were, in fact, advertised at the end of Beman and Smith's 1896 geometry as "The most Popular Text-Books issued within the past Decade."
[43] The peculiar nature of this collaboration was noticed by Smith's contemporaries. For example, see the review in *Journal of Education* 70 (1909): 218.

in his career, then, Smith positioned himself as a voice of restraint against both radical reformers and traditionalists.

Smith also made an important original contribution to mathematical pedagogy via his interest in the history of math. As far back as his collaboration with Beman, Smith included in his textbooks historical notes “designed to increase the interest of the student.”[44] This appeal to the interests of children used logic like that of the Midwestern reformers, who advocated the teaching of concrete examples before diving into abstract work. The historical digressions in this work tended to be very brief and consisted only of dry statements of fact: for example, after proving that the three interior angles of a triangle add up to 180°, Smith merely noted that the theorem “is attributed to Pythagoras” and “is one of the most important of geometry.”[45] However, textbook notes do not give a full sense of Smith’s use of history in the classroom: in a 1913 address, he brought up history as a way to increase interest in mathematics, noting that “I do not think much of it as it appears in the form of notes in a text-book, but as outside material to be brought into class, to be the subject of a moment's inspiring talk by the teacher,—this is where its value seems to lie.”[46] Smith’s textbook notes were not themselves meant to entertain children, but were to be used as guidelines for the topics teachers could bring up in fuller detail themselves. A properly-trained math teacher, in Smith’s eyes, would not only understand the subject well, but would know enough of its history to bring the subject to life for students. This is further evidence of Smith’s faith in the abilities of teachers and his tendency to view reform as bottom-up rather than top-down.

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[44] Beman and Smith, *Geometry*, iv.

[45] Beman and Smith, *Geometry*, 43.

[46] David E. Smith, “Certain Problems in the Teaching of Secondary Mathematics, *Mathematics Teacher* 5 (1913): 175.

William Betz provides a good example of Smith's growing influence on math teachers over the first decade of the twentieth century. Betz, a high school teacher from Rochester, first reached out to Smith in 1904 to request a meeting to discuss contemporary problems in math teaching.[47] After complimenting Smith for the fame he had attained among math teachers, Betz explained that "in the modern conflict between the empirical school (Chicago), and the rational school (Halsted), (my own terms) I have occupied an intermediate position. We are living in a transition period. It seems to me folly to sacrifice the disciplinary value of the subject. At the same time, why should we not use every means known to us to make the subject attractive, practical, interesting, valuable, etc. The two sides are not at all antagonistic." Younger teachers such as Betz wanted moderate, common-sense reforms in math teaching and looked up to Smith as a leader. It is also worth noting that Betz's own geometry textbook began with a brief historical introduction to Egyptian and Greek geometry, showing a similar attitude toward student interest as Smith.[48] Smith, for his part, recognized Betz's similar stance on pedagogy and rewarded him for it: in 1907, after just a few years of professional communication, Smith negotiated Betz's appointment to the Teachers College faculty and promised him the opportunity to raise the standards of math teaching across the country.[49] Smith's skill at helping younger, like-minded mathematicians navigate the professional world will be discussed in more detail in a later chapter; for now it is sufficient to say that by this point in Smith's career he was one of the

[47] Letter from Betz to Smith, Dec. 21, 1904, *David Eugene Smith (DES) Professional Papers* box 5. In the same letter, Betz mentions traveling to Germany and meeting and being influenced by Felix Klein, providing further evidence for the common intellectual environment of American mathematicians. Halsted was a Princeton mathematician with an even stronger commitment to abstract rigor than Osgood. He often critiqued the softness of American teaching but rarely engaged in the pedagogical discussion.

[48] William Betz and Harrison E. Webb, *Plane Geometry* (Boston: Ginn & Co., 1912), 1-3. Like Smith's texts discussed above, this work's preface declares itself to be a compromise between the extreme demands of reformers and conservatives.

[49] Letters between Betz and Smith from Mar. 1907 to May 1907, *DES Professional Papers* box 5. After much indecision, Betz decided to stay in Rochester.

most well-known math educators in the country and held considerable influence on the direction the reform effort would take.

Smith's Leadership and the IMUK

Smith's largest undertaking during this phase of his career was his leading role in the International Commission on the Teaching of Mathematics (usually abbreviated IMUK according to its German title, *Internationale Mathematische Unterrichtskommission*). This organization came into being in 1908 at the Fourth International Congress of Mathematicians, with the goal of providing a comprehensive report on the state of secondary mathematics education in the various nations of Europe and North America in time for the Fifth Congress in 1912.[50] While Felix Klein proposed the IMUK at the 1908 Congress and served as its president, it is the consensus among historians and contemporaries that Smith pushed Klein to set the project in motion.[51] The IMUK thus serves as a useful reference point for Smith's career, revealing his considerable influence among American and European math educators.

With the central committee of the IMUK dominated by Europeans, the United States was allotted three delegates to oversee the investigation of American math teaching. Smith, with his initiative in beginning the project, was an obvious first choice. Looking for a second commissioner, Smith reached out to Osgood in the summer of 1908. Osgood reluctantly accepted: "it is clear that the 'reformers' of the Slaught-Lennes kind [two Midwestern educators] will want to recommend things that I, for one, believe to be wrong. [...] I should not think it feasible for me to serve with a representative of the radical movement in America. On the other

[50] David E. Smith, "The American Work of the International Commission on the Teaching of Mathematics," *Mathematics Teacher* 2 (1909): 56.
[51] Roberts, "Mathematics and Pedagogy," 352-353. I have not read the letters from Klein to Smith from this period, as they were written in German.

hand, the radicals are making all the noise, and they are going to continue to talk a blue streak."[52] Osgood expected the Chicago style of reform to dominate the committee and felt obligated to provide balance through his own participation. With these positions filled, the obvious choice would be a "radical" third member to balance Osgood. Smith and Osgood agreed that J. W. A. Young would fit this role, explaining to Klein that "as Professor Osgood and I represent somewhat different attitudes with respect to the work, so Professor Young represents a position different from that of either of us."[53] The American delegates valued balance, both ideologically and geographically, and strove to include all voices within the teaching community in the commission's work. Young and Osgood agreed that Smith ought to be chair of the American commission, citing his normal school experience and closer connection to secondary education.[54] Given Osgood's distaste for the Chicago style of reform, Smith was also the most politically neutral choice to head the commission. Although all sides got a voice in the American commission, the moderate faction spoke loudest.

What followed was a chaotic three-year period in which Young, Smith, and Osgood communicated furiously with one another and with math educators across America, trying to fill committee and subcommittee memberships, find money to pay for publications, and meet the 1912 deadline. Smith quickly reached out to the U.S. Commissioner of Education, Elmer Ellsworth Brown, looking to secure support from the federal government.[55] He was not successful in this: while France and Germany had given strong support to their respective IMUK

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[52] Letter from Osgood to Smith, July 29, 1908, *DES Professional Papers* box 37.

[53] Letter from Smith to Klein, Oct. 5, 1908, *DES Professional Papers* box 29. Young accepted Smith's invitation in a letter of Nov. 21, 1908, *DES Professional Papers* box 56.

[54] Letter from Osgood to Smith, Feb. 13, 1909, *DES Professional Papers* box 37.

[55] Letter from Smith to Brown, Oct. 16, 1908, *DES Professional Papers* box 7. Brown headed the Bureau of Education, a small organization within the Department of the Interior. The Department of Education would not be founded until 1979.

commissions, America's Bureau of Education ended up taking a backseat role.[56] In contrast with the present situation, in which the federal government actively sets the educational agenda, the early-twentieth century saw the government deferring to the professional communities surrounding individual subjects. Smith asked Brown whether the Bureau could help the American investigation financially and received a definite (though apologetic) no: the Bureau was itself struggling to get more funds from Congress and expected a budgetary increase of only $5,700 in 1909.[57] Without government funds, the American commissioners could not afford to meet in person or travel extensively as part of their work; the IMUK thus served to test the potential for communication within the professional infrastructure that the mathematics community had built up over the previous 30 years.[58]

The scope of the IMUK and the status of those who were invited to participate serve as good evidence of its success and the triumph of the country's mathematical community. America's investigation into math teaching consisted of 12 committees (covering topics such as "mathematics in the elementary schools," "mathematics in the technical secondary schools," and "examinations in mathematics") divided into a total of over 50 subcommittees, each consisting of three to five members. The committee on examinations included, for example, subcommittees dealing with admission into secondary schools, college entrance tests, college entry via certification, and examinations to test teachers. Most of the prominent math educators of the 1900s and 1910s participated in the IMUK in some capacity: E. H. Moore served on an advisory council (reflecting his more passive engagement with teaching issues at that point); Betz headed

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[56] Letter from Smith to Brown, Jan. 22, 1909, *DES Professional Papers* box 7.

[57] Letter from Brown to Smith, Feb. 10, 1909, *DES Professional Papers* box 7. The letter does not mention the size of the previous year's budget for comparison.

[58] I find no definitive summary of how the commission was financed, but the three commissioners were able to secure $200 each from their respective universities. Letter from Young to Smith and Osgood, May 13, 1909, *DES Professional Papers* box 56. Smith also mentions using his own money to cover some expenses, but this may have been written with the expectation of eventually being paid back by Teachers College.

a subcommittee investigating the failures of current secondary math education; the reform wing was well-represented with Chicago teachers such as Ernst Breslich, G. W. Myers, and Herbert Slaught; and then-unknown educators who would later collaborate with Smith on the history of mathematics such as Louis Karpinski and Lao Genevra Simons made minor contributions.[59] In spite of its lack of funding and occasional failure to meet deadlines, the project's ultimate success provided proof of the American math teaching community's cohesion and organizational capacity.

To give an example of how this delegating process worked: In April 1909, Young suggested E. H. Taylor of Charleston, Illinois (that is, a Midwesterner), to chair the committee on teacher training, citing his good reputation and experience working with Osgood in the past.[60] After clearing the choice with all three commissioners, Smith (not Young) wrote to Taylor, who agreed to take the position.[61] Smith then provided a list of potential subcommittee members, to which Taylor added his own suggestions.[62] Despite the difficulties of carrying on this sort of multipolar conversation through the mail service, the commissioners made the appointment without trouble. Other times, the bureaucracy of the project got in the way of such smooth functioning: around the same time, Young noted that most of the committee chairs were held by Easterners and suggested that the chair of the committee on private high schools should be given to a Westerner.[63] Smith apologized that he had already offered the position to the superintendent of Hackensack, New Jersey (a position that clearly dealt with public rather than private

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[59] *Report of the American Commissioners of the International Commission on the Teaching of Mathematics* (Washington: Government Printing Office, 1912), 67-76. A full list of committee membership is given here.
[60] Letter from Young to Smith and Osgood, Apr. 5, 1909, *DES Professional Papers* box 56.
[61] Letter from Taylor to Smith, May 2, 1909, *DES Professional Papers* box 51.
[62] Letters of May 5 and 13, 1909, *DES Professional Papers* box 51.
[63] Letter from Young to Smith, Apr. 22, 1909, *DES Professional Papers* box 56. Note the exclusion of Osgood from this conversation. Young was right to point out the dominance of Easterners: out of 12 committees, 10 were chaired by Northeasterners.

schooling), explaining that he had not expected Young to feel strongly about the position and that in any case they were working on a strict schedule so the appointment would stand.[64] The politics of geography (and, implicitly, of different schools of reform) were still visible beneath the cooperation between Smith, Young, and Osgood, but this should not detract from their success in bringing the community together.

The IMUK's immediate impact was to reveal the weakness of American math education in comparison to Europe. With regard to the training of math teachers (one of Smith's favorite topics), the IMUK found the highest standards in France, Germany, Denmark, and Sweden, with Britain and the U.S. lagging far behind.[65] This only confirmed what Smith knew from his experience teaching in normal schools, where young teachers often had no mathematical knowledge beyond elementary arithmetic and algebra. Attempts to make direct comparisons only reinforced America's low standards: graduates from the French *lycées* were already on par with American university sophomores; German teachers were required to have broad knowledge of philosophy, religion, and literature, unlike the uncultured Americans.[66] The arrangement and scope of the curriculum also provided examples of America's subpar status. In Europe, algebra and geometry were introduced earlier and studied more intensively, different courses were correlated with one another (a reform Moore had suggested a decade ago but which had not been widely adopted), and advanced topics such as trigonometry were regularly taught.[67] Writing retrospectively over the next few decades, Smith tended to portray the IMUK as a shock to

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[64] Letter from Smith to Young, Apr. 24, 1909, *DES Professional Papers* box 56. I find no sign that Young resisted this decision by Smith.

[65] Raymond C. Archibald, *The Training of Teachers of Mathematics for the Secondary Schools of the Countries Represented in the International Commission on the Teaching of Mathematics* (Washington: Government Printing Office, 1918), 217.

[66] Archibald, *Training of Teachers*, 68, 88.

[67] J. C. Brown, *Curricula in Mathematics: A Comparison of Courses in the Countries Represented in the International Commission on the Teaching of Mathematics* (Washington: Government Printing Office, 1915), 88.

American mathematicians that drove them to catch up to Europe and energized the reform movement.[68] Given the scale of the project and the list of significant names that made contributions, it is reasonable to trust Smith's judgment that the IMUK had a considerable impact on American math teaching.

The final report of the three American commissioners summed up the state of American math education in 1912, identifying its problems and pointing toward solutions. The main theme of this report was the lack of adequate training for American teachers. The United States, the commissioners argued, faced a particular challenge here, given the country's geographic size and its rapid population growth, from 31 million in 1860 to 92 million in 1910.[69] With so many children to teach, the schools scrambled to fill positions and made due with teachers who did not have a solid grasp of mathematics. Despite the vigorous reform debates over the previous ten years, this rapid growth had prevented the teaching community from actually implementing new ideas on a large scale: "the man battling with a flood must struggle for his life; he can not be carrying out reforms."[70] It is important to remember that most mathematics teachers in the U.S. (especially in the elementary schools) were young women who were not socialized to join their regional professional organization or read periodicals from the MAA or NCTM and who typically only held the job for a few years before marriage.[71] The solution, then, would be to raise the standards expected of new math teachers and expand the self-consciously professional class that had emerged in the late nineteenth century. For example, the commissioners proposed that high school math teachers should be college graduates who have taken courses in calculus,

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[68] David E. Smith, "A General Survey of the Progress of Mathematics in Our High Schools in the Last Twenty-Five Years," in *National Council of Teachers of Mathematics Yearbook* 1 (1926): 8. Smith lists the Commission first in a list of positive influences on math teaching, suggesting its primacy to the later phase of teaching reform.
[69] *Report of the American Commissioners*, 10.
[70] *Report of the American Commissioners*, 12.
[71] *Report of the American Commissioners*, 11, 23.

physics, advanced geometry and algebra, some modern foundational mathematics, and specialized courses on the teaching and history of mathematics.[72] Along with some modernizing changes to the math curriculum, the commissioners saw this continued professionalization of teaching as the solution to America's backwardness.

The commissioners' report bears many marks of Smith's influence and shows how he balanced Young's empiricism and Osgood's formalism. Besides the aforementioned focus on teaching quality (one of Smith's pet issues), the report took a moderate attitude toward reform, recognizing the need for change while condemning blind experimentation. Among the "generally disastrous" experiments of recent years were the spiral method (which Smith had earlier tried in a more moderate form), the restriction of mathematics to too narrow a field of applications, the consolidation of math classes into fewer years in order to improve efficiency, and eliminating math classes altogether, only teaching math as it appears incidentally in other subjects.[73] For Smith, all of these experiments were too radical a break with the past. Two "failures" deserve special attention: the report condemned both the total abandonment of abstract work in favor of mathematical applications and the neglect of applications in favor of abstract mechanicalism. Certainly, it was not the case that Young's reformism was totally application-focused or that Osgood wanted all math teaching to be purely abstract; both leaned toward these extremes but brought more subtlety in their positions. Nevertheless, this rejection of extremism in any form was characteristic of Smith's rhetoric over the previous two decades and suggests the other commissioners' submission to his vision of reform. The laboratory method was not even mentioned by name; Young seemed unwilling or unable to fight for its inclusion. As in so many

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[72] *Report of the American Commissioners*, 37-38.

[73] *Report of the American Commissioners*, 17. These last two experiments especially were likely influenced by the growing progressive education movement, with its preoccupation with scientific efficiency and challenging traditional subject-matter barriers. This will be discussed in the following chapter.

other areas, the commissioners' final report is evidence that Smith was the dominant voice among the American IMUK delegates.

By 1914, American mathematics educators had organized themselves into a healthy community on a national rather than merely regional scale. A network of societies and periodicals allowed cooperation on projects and discussions of pedagogical issues to reach a national scale. Distinct schools of thought had emerged and were engaging in constructive debate on the nature and purpose of math education. And with David Eugene Smith's leadership in the IMUK, the community showed a willingness to examine itself and to take part in international trends. Betz characterized this state of excitement in a letter to Smith: "we now have proof positive that mathematics is no longer the fossilized, dry-as-dust repository of rusty cans—once the delight of the elect—, but that it is the most virile, progressive element in the whole armory of philosophy and science."[74] While this progressive spirit was not always reflected in the reality of school teaching—which, then as today, is slow to change—the professional community of math teachers felt that they were living in a moment of genuine change and possibility within the field.

World War I did much to halt that momentum. The leaders of the International Commission had planned to continue their project, investigating math education in other parts of the world such as China, Latin America, and the various British colonies.[75] The war made any such international cooperation impossible, particularly with individuals from the Central Powers. This effectively ended the influence of Felix Klein, president of the IMUK and grandfather of American mathematics. Klein was one of the signatories of the infamous Manifesto of Ninety-Three, which celebrated German culture and denied the country's role in causing the war in the

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[74] Letter from Betz to Smith, Jan. 13, 1913, *DES Professional Papers* box 5.

[75] David E. Smith, untitled IMUK retrospective, *DES Professional Papers* box 84. The manuscript dates itself twelve years after the Commission began, meaning that it was written around 1920.

wake of the invasion of Belgium. Although the Americans, still neutral in the war, were less eager to punish Klein than their French and English counterparts, it became politically impossible for him to continue leading the IMUK and he eventually stepped down.[76] The American mathematics community had lost one of its strongest international allies. More broadly, the United States' entrance into the war drained the country's pool of young men and slowed the growth of professional mathematics. Oswald Veblen, one of the country's most prominent math researchers, resigned from his committee work to join the army.[77] These interruptions to the education community's normal functioning make the mid-1910s a natural point of discontinuity in its development. However, the war also coincided with an important shift in the nation's attitude toward math and a growing sense of crisis within the math education community, which will be the subject of the next chapter.

[76] Letter from Young to Smith and Osgood, Mar. 12, 1915, *DES Professional Papers* box 56. Soon after this, Smith was appointed president of the IMUK; however, given the organization's irrelevance after the war began, this appointment was not especially significant except as further evidence to his centrality to the project.

[77] *The Reorganization of Mathematics in Secondary Education* (Mathematical Association of America, 1923), viii.

Progressive Education and the Attack on Mathematics

Beginning in the mid-1910s, the math education community's mood turned dark. Mathematicians increasingly felt that their subject was under attack and feared that math might lose its place at the center of curriculum requirements. David Eugene Smith first gave voice to this thought in 1913, noting that "somebody to-day raises the question, 'Why should an educated man need to study algebra?'—and we, the teachers of mathematics, must answer."[1] He returned to the topic a few years later, warning that soon students would be allowed to enter college without any experience in high school math.[2] Alfred Davis of the MAA made a similar point in 1918, noting that "the challenge has come from various sources to us, as teachers of mathematics, to defend our subjects, especially algebra and geometry. A passive attitude is no longer tenable; we must make our position clear."[3] As late as 1935, Eric Temple Bell warned that "mathematicians are beginning to get their due share of those withering criticisms [...] which are only the first, mild zephyrs of the storm that is about to overwhelm us all. In the coming tempest only those things will be left standing that have something of demonstrable social importance to stand on."[4] The actions and writings of math educators during this period must be understood as a response to a protracted sense of crisis that permeated the community.

This chapter will explore the causes of this crisis and its effects on the math education community. Criticism came from the progressive education movement, which argued that mathematics' place in the curriculum was based on outdated psychology and that a truly modern,

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[1] David E. Smith, "Certain Problems in the Teaching of Secondary Mathematics," *Mathematics Teacher* 5 (1913): 162.
[2] David E. Smith, "What Is to Be the Outcome," *Mathematics Teacher* 9 (1916): 77-79.
[3] Alfred Davis, "Valid Aims and Purposes for the Study of Mathematics in Secondary Schools," *School Science and Mathematics* 18 (1918): 112.
[4] E. T. Bell, review of *The Poetry of Mathematics and Other Essays* by David E. Smith, *American Mathematical Monthly* 42 (1935): 559.

scientific education need not waste time with topics like algebra or geometry. While mathematicians continued to argue for the importance of their subject, they accepted the progressive logic of reform based in contemporary psychology. This was a strategic move that allowed math educators to present themselves as modern in the same way progressives did, but it also restricted their rhetorical options by invalidating the justifications for math education that had worked throughout the nineteenth century. Math educators had to find new justifications of their subject's worth based on math's uses in everyday life and its important role in human civilization. The crisis also strengthened the process of community-formation among mathematicians, inspiring new organizations and reports in defense of the subject. As the conflict between professions became more acute, the differences within math education discussed in the previous chapter became less pressing.

The Progressive Community and the Science of Pedagogy

Educators and historians agree that something called "progressive education" existed from roughly the 1890s to the 1950s, but it is difficult to come up with a concise definition of what the term means. Lawrence Cremin argued that progressive education was simply the educational phase of the broader Progressive Era; while this is useful in placing the movement in the cultural context of the reformism of Jane Addams or Jacob Riis, it does little to clarify the ideas that progressives actually supported.[5] The movement was incredibly broad, and two educators who identified themselves as progressives might have agreed on very little as to how a classroom ought to be run. Rather than attempting to work out the ideas shared by all progressives, this paper will identify progressives using the linguistic cues they repeated in their

[5] Lawrence Cremin, *The Transformation of the School: Progressivism in American Education, 1876-1957* (New York: Alfred A. Knopf, 1962), viii.

writings and speeches. Progressives tended to talk about education in the same way, even when the specifics of their beliefs differed. There was a broad consensus that education ought to be analyzed scientifically and made more efficient; that teachers ought to pay attention to the interests and unique needs of children to make school more humane; that learning should be active and should avoid abstract formalism or rote memorization; and that school should prepare children for the "real world," doing away with traditional, artificial subject-matter organization. These stated characteristics were exceptionally vague, but this made them useful: they were a means of eliding the distinctions between progressive educators and allowed them to view themselves as a unified movement.[6] These ideals made up the vocabulary of the progressives' language and could be invoked to demonstrate one's membership within the progressive community. In short, a progressive educator was simply someone who spoke the language of progressive pedagogy.

While professional math educators were organized around societies such as the AMS or MAA, the institutions tying together progressive education were the new schools of education. At the end of the nineteenth century, young Americans planning to become teachers typically passed through normal schools, either after finishing high school or in place of it. While the quality of these normal schools varied, they were targeted by reformers such as Smith who wanted to improve the quality of teacher training. By 1900, a quarter of the country's colleges and universities offered graduate training in education.[7] The most important of these was Teachers College, which became synonymous with progressive education itself. This was primarily the work of the school's president, James Earl Russell, who actively recruited reform-

[6] Cremin, *Transformation of the School*, viii-ix. Later, Cremin argues that this vagueness of language, which valued professional cohesion over properly-articulated ideas, paralyzed the movement in the long run. See *Transformation*, 181.

[7] Cremin, *Transformation of the School*, 169.

minded educators for the school's faculty.[8] John Dewey, who was quickly becoming the public face of progressive education, moved from the University of Chicago to Teachers College in 1904 and remained there for the rest of his career. Another early arrival was the child psychologist Edward Thorndike, who arrived in 1899 and began conducting the experiments that would make him famous.[9] The presence of active researchers set Teachers College apart from the older normal schools and pointed toward the professional identity of its progressive faculty: high expectations were placed on the school's students in subjects such as child psychology, the history of education, school administration, and the theory underlying educational technique, none of which were a part of the old normal school education.[10] This was not the professionalization of some particular branch of education, but of education itself, conceived of as an independent object of scientific study and improvement. This paper will use the term "general pedagogy" to refer to this view of education as a profession and stress its all-encompassing nature.

However, not every professor at Teachers College was a progressive. In addition to the general pedagogists such as Dewey, Thorndike, and their progressive colleagues, some of the early faculty at Teachers College were specialists in particular subject areas. Smith led the college's mathematics department; other early hires included the Latin professor Gonzalez Lodge and the historian Henry Johnson.[11] These professors were affiliated with the progressive-dominated college, but they also had their own allegiances to specific subjects and the professional networks associated with them. Teachers College housed two notions of

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[8] Lawrence Cremin, *History of Teachers College* (New York: Columbia University Press, 1954), 28, 39.
[9] Florence L. Goodenough, "Edward Lee Thorndike: 1874-1949," *The American Journal of Psychology* 63 (1950): 291.
[10] Cremin, *Transformation of the School*, 174.
[11] Cremin, *History of Teachers College*, 51. My intuition is that a study of Lodge's career at Teachers College would complement this thesis well and would reveal similar trends, as Latin suffered an attack similar to that on mathematics based on its lack of usefulness or disciplinary value.

professionalism that could easily come into conflict. The pedagogists viewed themselves as big-picture experts in education who had experimental psychology on their side and could speak authoritatively on any school subject. From the specialists' point of view, planning for a particular subject should be done by those who know it best, not by outsiders relying on pedagogical theory. The animosity between the two groups is illustrated by a popular rumor (probably apocryphal) that the three subject specialists liked to march down Riverside Drive singing "we are the scholars of Teachers College, the only scholars of Teachers College."[12] Consistent with his normal school background and faith in the "average" teacher, Smith did not see abstract pedagogical theorizing as proper educational scholarship, disconnected as it was from the realities of classroom teaching. This alienation from other faculty members persisted over the course of his career: writing retrospectively in 1936, he claimed that the first decade of Teachers College saw many excellent "teachers and scholars" joining the faculty, but as the school grew the balance shifted in favor of professors who taught "courses merely in the science of education."[13] Underlying Smith's disagreement with progressives about how to reform math education was a disagreement over what type of person was qualified to speak about mathematics.

One episode illustrates well how this professional territorialism operated. Early in his career, John Dewey published *The Psychology of Number*, his only work dealing specifically with math education.[14] The work was a clumsy application of late-nineteenth century psychology

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[12] Cremin, *History of Teachers College*, 53. Cremin mentions that this rumor might have been spurred by the jealousy of the Teachers College pedagogists, but does not pursue this thought further; it is characteristic of his style to ignore the internal divisions of Teachers College and present its faculty as unproblematically engaged in the same project of reform.

[13] Letter from Smith to Russell, Dec. 16, 1936, *David Eugene Smith (DES) Professional Papers* box 41.

[14] James A. McLellan and John Dewey, *The Psychology of Number and Its Applications to Methods of Teaching Arithmetic* (New York: D. Appleton & Co., 1895). McLellan was a Canadian educator with an interest in mathematics and psychology but no known connection to the American math community.

to arithmetic teaching and is not especially well-known today. Dewey argued that number consists of the three psychological facets contained in the act of counting—a whole object to be measured, the unit of measurement to be used, and the number of times the measurement is repeated—and that teachers who did not understand this could not teach math properly.[15] It is no surprise that reviewers criticized the book, but a review by the Princeton research mathematician Henry Fine stands out for the argument it used.[16] In place of Dewey's psychological definition, he claimed that the meaning of number must be established in the abstract language of set theory and one-to-one correspondence. When Fine argued that "the number of things in a group is not its measure, but [...] its 'invariant,' being for the group in relation to all transformations and substitutions what the discriminant of a quantic, say, is for the quantic in relation to linear transformations, unchangeable," it is hard to imagine that he expected Dewey to understand him.[17] His purpose was not to engage Dewey in a dialogue, but to demonstrate that only a mathematician was qualified to write about math education. Dewey published a response a few weeks later apologizing for "many blunders on the mathematical side" and spent the rest of his career generally avoiding the question of math education.[18]

Mental Discipline and Its Rejection

The competing self-conceptions of the progressive and math education communities made a conflict possible; the issue that finally triggered this conflict was the reevaluation of math's disciplinary value. Mental discipline was a psychological model that had structured

[15] McLellan and Dewey, *Psychology of Number*, 48, 157.
[16] H. B. Fine, *Science* 3 (1896): 134-136. I am indebted to Roberts for calling attention to this review in "Mathematics and Pedagogy: Professional Mathematicians and American Educational Reform, 1893-1923" (PhD diss., Johns Hopkins University, 1997), 129.
[17] Fine, 135.
[18] John Dewey, "Psychology of Number," *Science* 3 (1896): 288.

American education for most of the nineteenth century. Essentially, this was the idea that the mind is made up of several distinct faculties (such as perception, reasoning, and attention) that could be trained "in general," just as a muscle is strengthened through exercise.[19] This view is often associated with a statement of purpose issued by Yale College in 1828 that defined what we would today call a classical liberal arts education.[20] The report famously distinguished between "the *discipline* and the *furniture* of the mind": education could either strengthen and expand the mind itself or merely fill students' heads with discrete facts.[21] The conclusion was that the former of these was the better goal and that education should focus on the subjects most fit for exercising the mind. By the end of the nineteenth century, conventional wisdom held that Greek, Latin, classical texts, and mathematics were ideal for developing mental discipline and that any student hoping to attend college ought to focus on them. They were difficult, abstract, and usually taught in a boring way, but that made them ideal subjects for mental discipline.

For progressives, this view was dogma that represented everything wrong with old-fashioned education. Dry, difficult subjects might build discipline, they argued, but they also risked alienating students and destroying their interest in learning. Historians frame this as a debate of "interest versus effort," with older disciplinarians arguing that school should force students to work as hard as possible and younger progressives arguing that such practices were ineffective and inhumane.[22] Educators' opinions began to swing toward interest in the 1890s, but the definitive break with effort came with Edward Thorndike's famous 1901 study at Teachers

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[19] Walter B. Kolesnik, *Mental Discipline in Modern Education* (Madison: University of Wisconsin Press, 1958), 3-6. Kolesnik uses a slightly more intricate definition, differentiating between a more general theory of mind-improvement and the specific way that manifested at the end of the nineteenth century. "Mental discipline" as used here roughly corresponds with his notion of "formal discipline."

[20] "The Yale Report," in *The Colleges and the Public, 1787-1862*, ed. Theodore Rawson Crane (New York: Bureau of Publications, Teachers College, 1963), 83-99.

[21] "Yale Report," 85. Italics in original.

[22] Kliebard, *The Struggle for the American Curriculum, 1893-1958*, 3rd ed. (New York: Routledge Falmer, 2004), 47.

College "disproving" mental discipline.[23] Thorndike reasoned that, if mental discipline were real, then skills gained in one academic subject should improve students' performance in other subjects by way of strengthening their minds generally. To test how well skill at estimation transfers, Thorndike had students first estimate the areas of paper cutouts of different sizes. Then, he gave the students training in estimating the areas of rectangles until they were proficient. Finally, he re-tested their estimations of the original shapes to see if the students' rectangle training could be applied to other shapes. Based on the students' lack of improvement, Thorndike concluded that the skill did not transfer between different shapes.[24] Using a few other similar tests, Thorndike claimed that the old idea of mental discipline was scientifically invalid: the mind was not an all-purpose muscle that grew more disciplined as a whole, but rather "on its dynamic side a machine for making particular reactions to particular situations."[25]

Whatever a modern observer might think about Thorndike's methodology, the study's effect on teaching cannot be doubted.[26] In the words of Peter Sandiford, the 1901 study "cast a veritable bombshell into the educational camp. [...] The educational world was immediately up in arms."[27] Progressives were already sure that the old educational paradigms were wrong; they embraced the study as scientific "proof" that their view was correct. Difficulty, they concluded, could no longer be accepted as a goal by itself. Instead, the purpose of education must be preparation for the specific situations where classroom knowledge could be applied. No subject could remain in the required curriculum based simply on tradition or its supposed disciplinary

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[23] E. L. Thorndike and R. S. Woodworth, "The Influence of Improvement in One Mental Function upon the Efficiency of Other Functions," *Psychological Review* 8 (1901): 247-261.
[24] Thorndike and Woodworth, "Efficiency," 252-253.
[25] Thorndike and Woodworth, "Efficiency," 249.
[26] Kolesnik, *Mental Discipline*, 30-61. Kolesnik discusses individual reactions to Thorndike's study in much greater detail than can be given here.
[27] Kolesnik, *Mental Discipline*, 34. Quoted from *Educational Psychology* (London: Longmans, Green, 1930), 280. It is worth noting that Sandiford was a former student of Thorndike.

value; instead, all subjects had to make a positive case for why students would need them. Mathematicians had never had to deal with this problem before, as it had been taken for granted that math would be taught for its disciplinary value. Previous discussions among mathematicians had concerned how mathematics should be taught; now mathematicians had to face educators outside their profession and argue whether mathematics should be taught at all.

One response was simply to deny that mental discipline had been disproven. Throughout his career, Smith argued that the case against discipline was less clear-cut than Thorndike had claimed. He portrayed himself as a sober voice of reason who was correcting radical progressives' attempts to do away with discipline altogether. Trying to downplay the influence of Thorndike's findings, he wrote in 1913 that the "explosion" of mental discipline was "a beautiful catch phrase that was quite fashionable for a time," painting it as a fad.[28] A decade later, with the fad refusing to go away, Smith wrote that "the claim [against mental discipline] was formerly exaggerated, although the efforts of the psychologists to weigh the value of arithmetic, or of any other subject of study, have not progressed far enough to produce results that can be described as other than somewhat crude."[29] Smith's claims here are simply statements of fact without any experimental evidence of his own to cite—he was, after all, a mathematician, and experimental psychology was a tool of the progressive faction. He instead turned to his favorite justification of common sense, arguing that we must "fall back upon our own experience," with experimental psychology playing a supporting role.[30] Downplaying the conclusiveness of Thorndike's study was one tactic available to mathematicians, but this was ultimately a rearguard defense that held

[28] David E. Smith, "Certain Problems in the Teaching of Secondary Mathematics," *Mathematics Teacher* 5 (1913): 170.
[29] David E. Smith, *The Progress of Arithmetic in the Last Quarter of a Century* (Ginn & Co.: Boston, 1923), 14.
[30] Smith, *Progress of Arithmetic*, 14.

little power; in the early twentieth century, mental discipline ceased to be a useful means of justifying math teaching.

The Attack on Mathematics

Thorndike's conclusions were immediately accepted among many educators, but the tone of crisis does not appear in Smith's writings for at least another decade. Smith, as a professor at Teachers College, was more aware of trends in progressive education than his fellow mathematicians and was probably the first to notice a backlash against math's place in the curriculum, so it is useful to use his writing as a benchmark for when the crisis began. The change in the 1910s was the arrival at Teachers College of several particularly vocal opponents of math education. In 1917, Smith privately complained to President Russell that radically destructive rhetoric aimed against traditional school subjects had become associated with Teachers College and had led to declining interest in the specialized subjects among the college's students.[31] He took a much harsher tone than was typical of his published writings, criticizing the professors who wanted to turn the school into "a hotbed of educational Bolshevism" by destroying the existing educational paradigm without putting anything in its place and who insulted anyone who clung to mental discipline as an "old fogy."[32] Without naming any faculty members in particular, Smith singled out "at least four of our colleagues" as particularly destructive.[33] The identity of these four is unknown, but it is possible to single out two professors

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[31] David E. Smith, "Confidential Memorandum for Dean Russell," *DES* Professional Papers box 41. The memorandum is undated, but is sorted between material from 1917 and makes mention of an ongoing war.
[32] Smith, "Memorandum."
[33] Smith, "Memorandum."

who were especially active in the attack on math education: David Snedden and William Kilpatrick.[34]

David Snedden was one of the progressive education movement's foremost proponents of social efficiency. This was the school of thought that saw modern industry as a model of efficiency and proper management and sought to apply its techniques to other areas of society. The 1910s saw this movement flourishing in America's major cities: in 1915, Robert Moses attempted a reform of New York's civil service, "scientifically" assigning workers their salaries by grading performance in each of the job's functions.[35] After the country's entry into World War I, Robert Yerkes, president of the American Psychological Association, cooperated with the army in administering mass intelligence testing on new recruits to weed out incompetents, an event that boosted the popularity of such quantitative intelligence grading.[36] Snedden embraced this logic of efficiency through quantification and analysis and sought to introduce it to the school system. He took his doctorate at Teachers College, then briefly served as the Massachusetts commissioner of education before returning to the school as a professor in 1916—around the same time Smith began to notice a concerted attack on mathematics.[37]

Snedden's essential argument throughout his career was that school (especially high school) should prepare children for adult life: humans went through a few years of childhood followed by many decades of adulthood, so the efficient choice would be to teach children the

[34] Thorndike, for his part, was an early critic of required mathematics, claiming in 1906 that probably only a third of students ought to take algebra and geometry. I find no evidence of a response from Smith. Edward L. Thorndike, "The Opportunity of the High School," *The Bookman* 24 (1906): 181

[35] Robert Caro, *The Power Broker: Robert Moses and the Fall of New York* (New York: Vintage Books, 1975), 74-75.

[36] Cremin, *Transformation of the School*, 187-188.

[37] Kliebard, *Struggle*, 94-95.

skills they would need as adults.[38] This could be accomplished, Snedden argued, by exhaustively identifying the desired outcomes of education, finding the most efficient ways to achieve those goals, and matching students with the outcomes that best matched their interests and strengths. Rather than academic knowledge on literature or geography, the objectives of high school should be personal traits such as physical health and hygiene, aesthetic appreciation, civic habits, and especially vocational guidance.[39] These goals might not seem purely utilitarian, as "useless" subjects such as art or music still had their place, but Snedden's system analyzed all subjects through the same Taylorist, efficiency-maximizing lens that saw them ultimately as means to other ends. Aesthetic subjects were not taught for their own sake, but under the assumption that art had a definite social value that schools should strive to maximize—and, Snedden argued, if art should lose that social function, then it should be removed from the curriculum in equal measure.[40] The goals of high school education provided Snedden with an objective set of criteria for determining which school subjects were most efficient and which could be dropped.

Based on Thorndike's mental discipline study, Snedden concluded that high school math did not fulfill any objective well enough to be required of all students. As early as 1912 he was arguing that high school math only had value for students intending to continue to college or specific math-related vocations; he stuck with this thinking through the rest of his career.[41] This quickly earned him a reputation among mathematicians as an enemy of the subject. In a review of several books in *Science*, the Columbia mathematician Cassius J. Keyser made an unprompted reference to "the nation-wide depreciatory utterances of such educational leaders and agitators as

[38] Kliebard, *Struggle*, 95. This argument was directed against child developmentalists such as W. H. Kilpatrick (discussed below), who argued that forcing adulthood upon students was unnatural and would stunt their growth.
[39] David Snedden, "The High School of Tomorrow," *The School Review* 25 (1917): 3-6.
[40] David Snedden, "The Waning Powers of Art," *American Journal of Sociology* 22 (1917): 801-821.
[41] David Snedden, "The Opportunity of the Small High School," *The School Review* 20 (1912): 108.

Commissioner Snedden and Abraham Flexner."[42] Snedden apparently noticed the passing comment and felt compelled to write a letter of response to the magazine a few days later.[43] He denied that he was anti-math, arguing that he only wanted to question the subject's privileged place as a required subject for all high school students. Children should be encouraged to learn more math—if they intended to enter a career where it would be needed. This focus on vocational readiness also had a gendered component that Snedden called attention to: with most young girls destined to become housewives, he reasoned, would it not be more efficient to teach them home economics rather than algebra?[44] Even arithmetic, which only the most radical progressives wanted to make elective, was not safe from Snedden's efficiency analysis. He argued that the arithmetic syllabus still included many useless or archaic subjects (such as, for example, the metric system), and that some time teaching the subject would be better spent preparing children for adult life.[45] Regardless of how much Snedden downplayed his opposition to math, the reforms he suggested would have radically diminished American children's exposure to school mathematics.

During their time together at Teachers College, Smith and Snedden enjoyed a relationship that was tense, yet remained within the expected norms of professional behavior. As early as 1907, Snedden dismissed some of Smith's strongest convictions about teaching. Whereas Smith held the common sense of average teachers in high regard and viewed textbooks more as guides than prescriptions, Snedden admitted that he had "little faith in 'the teacher's ability to use the existing text books on algebra and geometry in the spirit here suggested.' [...] I

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[42] Cassius J. Keyser, "Recent Books in Mathematics," *Science* 44 (1916): 27. Flexner had recently written an influential article on school reform along similar utilitarian lines as Snedden. See Cremin, *Transformation of the School*, 280-281.
[43] David Snedden, "Compulsory Mathematics—An Explanation," *Science* 44 (1916): 204-205.
[44] Snedden, "Explanation," 205.
[45] David Snedden, "Arithmetic in the Schools," *School and Society* 20 (1924): 176.

think it almost necessary that teachers' handbooks, manuals, or something of the sort should be available."[46] This attempt to standardize teaching practice through manuals produced by experts is consistent with Snedden's general philosophy of industrial efficiency. This disagreement did not prevent the two from working together: surprisingly, Smith invited Snedden to participate in the International Commission on the Teaching of Mathematics as the head of a subcommittee surveying American educational institutions within the committee on elementary schools.[47] However, his participation did nothing to change Snedden's attitude toward math education. In 1917, after thanking Smith for sending a copy of his new book on junior high school arithmetic, Snedden began a page-long discussion of why more math ought to be elective, even including a schematic detailing which areas should be required and which should not.[48] Smith and Snedden were open to discussing their ideas on math education, although they rarely agreed on how to teach the subject.

A series of exchanges from early 1919 best sums up the relationship between the two professors. Smith first proposed a meeting between himself, Snedden, and a few other progressives in which he could explain the current work being done in the Teachers College math department, explaining that it would be useful "if those of you who are so much in demand as speakers could know somewhat more at first hand the possibilities of constructing such new courses as this department is advocating."[49] Couched within Smith's polite language and complex syntax was the assertion that progressives talked too much given how little they knew

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[46] Letter from Snedden to Smith, May 10, 1907, *DES Professional Papers* box 49.

[47] *Report of the American Commissioners of the International Commission on the Teaching of Mathematics* (Washington: Government Printing Office, 1912), 68. It is unclear who reached out to Snedden and for what reason, as the Smith-Snedden correspondences do not include any letters inviting Snedden to participate in the IMUK. It is, of course, possible that Smith simply asked Snedden in person.

[48] Letter from Snedden to Smith, Oct. 15, 1917, *DES Professional Papers* box 49. The introduction of the junior high school between elementary and high school was one of the most concrete achievements of progressive education and occurred over the 1910s and 1920s.

[49] Letter from Smith to Snedden, Briggs, and Kandel, Jan. 7, 1919, *DES Professional Papers* box 49.

about mathematical pedagogy. In letters over the next few weeks both authors laid out their conceptions of the purpose of math teaching: Snedden argued that, beyond the simple arithmetic needed by everyone, math is purely vocational and should only be taught to students who will need it in future careers; Smith responded that math's uses were much broader than Snedden believed and that the solution was not to cut math from the schools but to improve its teaching.[50] All these ideas were expressed politely, although there was always a strong sense of animosity beneath the surface: at one point Smith advised Snedden that his arguments were unclear and that he ought to have studied more mathematics in school to improve his reasoning, echoing Fine's critique of Dewey two decades earlier (Snedden defensively replied that he had, in fact, done very well in mathematics as a student).[51] At another point Smith tried to rephrase some of Snedden's arguments in his own words, using such neutral phrasings as "[...] but in doing so I do not add to the clearness of my argument," or "there is no definite conclusion to be reached from my study."[52] Smith insisted that his summary was not intended to be taken sarcastically. Given this barely-contained anger, it is a wonder that the two continued their discussion at all.

While Smith's relationship with Snedden was merely tense, William Heard Kilpatrick was the closest thing to a rival Smith had at Teachers College. He was one of the most popular teachers in the school's history and regularly filled halls with his lectures, giving him the perfect platform to spread the educational "Bolshevism" that Smith feared.[53] Kilpatrick's educational celebrity was launched in 1918 with the publication of "The Project Method" in the *Teachers*

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[50] *DES Professional Papers* box 49. See especially Snedden's letter of Jan. 13 and Smith's letter of Jan. 14.
[51] Letter from Smith to Snedden, Jan. 31, 1919; letter from Snedden to Smith, Feb. 4, 1919, *DES Professional Papers* box 49.
[52] "A Summary," attached to a letter from Smith to Snedden, Jan. 31, 1919, *DES Professional Papers* box 49.
[53] Lawrence Cremin estimates that 35,000 students passed through Kilpatrick's classes over his career at Teachers College. See Cremin, *Transformation of the School*, 220.

College Record, which went through over ten printings over the next decade.[54] Kilpatrick argued that a key component of life in a democracy, and one that was missing from America's schools, was "purposeful activity": rather than blindly follow the orders of an authority figure, someone acting purposefully will intend to do something, plan it out on his or her own, and carry it through to completion.[55] Kilpatrick named this cycle of deliberate work a "project" and proposed that school be arranged not according to separate subject areas but as a series of holistic projects that could freely incorporate any number of school subjects, or avoid the traditional subjects altogether. This focus on learning-by-doing and endogenous motivation earned Kilpatrick the reputation as Dewey's intellectual successor, further boosting his celebrity credentials. In contrast to Snedden, who viewed education primarily as preparation for future life, Kilpatrick declared that education was itself life, adding that "if the purposeful act be in reality the typical unit of the worthy life, then it follows that to base education on purposeful acts is exactly to identify the process of education with worthy living itself."[56] Educators who did not subscribe to social efficiency thinking welcomed Kilpatrick's more naturalistic, child-sympathetic approach to reform.

The project method, as described above, does not seem to conflict with school mathematics; one can easily imagine projects that involve mathematical thinking.[57] In reality, Kilpatrick subscribed to the view of many progressives that mathematics lacked disciplinary value and was a waste of time for most students. While Smith could claim that Snedden was too ignorant of math to comment on its teaching, Kilpatrick had an extensive knowledge of the

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[54] William Heard Kilpatrick, *The Project Method: The Use of the Purposeful Act in the Educative Process* (New York: Teachers College, 1918). Originally published in *Teachers College Record* 19, no. 4 (1918). Kliebard gives a good account of Kilpatrick's rise to fame and Snedden's accidental part in it in *Struggle*, 133-138.
[55] Kilpatrick, *Project Method*, 5.
[56] Kilpatrick, *Project Method*, 6.
[57] Kilpatrick himself suggested the solving of an "original" geometry problem (as opposed to memorizing an existing proof, presumably) as a suitable project. See Kilpatrick, *Project Method*, 5.

subject, having studied mathematics at Mercer College and as a graduate student at Johns Hopkins.[58] This made Kilpatrick a particular danger for math educators: their usual defense was made along professional lines, arguing that the course of math education should be decided by those who actually understood mathematics. But Kilpatrick confounded this line of thinking, proposing the abandonment of high school math requirements despite his knowledge of the subject.

Kilpatrick's ambivalence toward math emerged clearly in his chairing of the mathematics committee of the Commission on the Reorganization of Secondary Education (CRSE). This widely-praised commission, headed by Snedden's protege Clarence Kingsley, is often taken as a definitive statement of either social efficiency specifically or progressive education in general.[59] While the CRSE as a whole was dominated by the social efficiency thinkers, the math committee's report gave Kilpatrick the chance to articulate his own views on math requirements.[60] The report summarized many progressive arguments on why school mathematics requirements needed to be reconsidered: because all subjects needed to justify their own purpose scientifically rather than through tradition, because of the rejection of mental discipline, because different students have different needs and interests, and because many students did not intend to continue to college and thus should not suffer through college-preparation classes.[61] Although it presented itself as a preliminary report and suggested further experimentation with the math curriculum, it made the concrete suggestion of separating students into four groups, each with a different sequence of math classes: "general readers" (those students who will only need some

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[58] John A. Beineke, *And There Were Giants in the Land: The Life of William Heard Kilpatrick* (New York: Peter Lang, 1998), 18-19.
[59] Kliebard, *Struggle*, 96-98.
[60] *The Problem of Mathematics in Secondary Education: A Report of the Commission on the Reorganization of Secondary Education, Appointed by the National Education Association* (Washington: Government Printing Office, 1920).
[61] *Problem of Mathematics*, 10-11.

basic arithmetic to get through daily life), future tradespeople (who might need more advanced arithmetic for accounting and bookkeeping), future scientists and engineers, and future mathematicians.[62] Under the rule that "no item shall be retained for any specific group of pupils unless [...] its (probable) value can be shown," the report suggested that most students should only be required to take math through ninth grade.[63] Kilpatrick did not have much to say about the fourth group, those strange "boys and girls who 'like' mathematics," suggesting that they follow the classic curriculum with a less strict separation of algebra, geometry, and trigonometry, somewhat similar to the suggestions of E. H. Moore and J. W. A. Young discussed previously.[64]

Kilpatrick's antagonism toward mathematics is also visible in his relationship with Smith, which was even more strained than Snedden's. Before beginning the report, Kilpatrick sent Smith a list of potential committee members to gather feedback. Smith reacted with surprise, noting that Kilpatrick's committee would not be taken seriously given its lack of well-known mathematicians and the "cranks" who had made it onto the list. Smith instead recommended some well-known names from the mathematical community, including W. F. Osgood, Smith's close associates L. C. Karpinski and R. C. Archibald, and J. W. A. Young, noting that the last "is a progressive man, but is not a crank."[65] Kilpatrick gave no indication that he ever received the letter and ignored Smith's advice: the final committee was dominated by school administrators and pedagogical researchers rather than mathematicians.[66] For whatever reason, Kilpatrick returned to Smith for suggestions a year later, asking for comments on a draft of the CRSE

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[62] *Problem of Mathematics*, 17-21.
[63] *Problem of Mathematics*, 15.
[64] *Problem of Mathematics*, 20.
[65] Letter from Smith to Kilpatrick, Jan. 13, 1916, *DES Professional Papers* box 29.
[66] *Problem of Mathematics*, 3.

report.[67] Smith again voiced his disapproval, arguing first that the report did not actually say anything new and was simply repeating progressive truisms, and second that the language of the report would prevent it from being taken seriously by the mathematicians (recall the characterization of children who "like" mathematics above).[68] Kilpatrick's response is nearly incomprehensible, as he thanked Smith for "approv[ing] so generally the principles enunciated."[69] Whereas Snedden tried to reason with Smith and maintain open communication, Kilpatrick simply bulldozed over Smith's arguments, cutting off any real dialogue between the two. Their catalogued correspondence ends in May 1918, two years before Kilpatrick's report was published and a few months before "The Project Method."

In Smith's communications with other math educators, Kilpatrick served as a symbol for all the misguided trends of progressive education. A few months after criticizing Kilpatrick's list of committee members, Smith wrote his colleague Lao Simons of Hunter College and dismissed Kilpatrick's ideas as "a mere attack without any basis."[70] Vera Sanford, one of Smith's Ph.D. students, complained of a "Kilpatrickized affair" she had witnessed in her school: the project involved students describing their recent trip to the New York Stock Exchange and what they had learned from it, followed by an economist correcting the false statements the children had made.[71] In this characterization, projects had less to do with purposeful activity and more to do with children following their own whims and missing out on real learning. In another letter, Sanford made a passing comment on the public enthusiasm for progressive methods, joking that

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[67] Letter from Kilpatrick to Smith, Feb. 6, 1917, *DES Professional Papers* box 29. Kilpatrick's draft is not included alongside the letter.
[68] Letter from Smith to Kilpatrick, Feb. 15, 1917, *DES Professional Papers* box 29.
[69] Letter from Kilpatrick to Smith, Feb. 23, 1917, *DES Professional Papers* box 29.
[70] Letter from Smith to Simons, Mar. 31, 1916, *DES Professional Papers* box 45.
[71] Letter from Sanford to Smith, Mar. 18, 1928, *DES Professional Papers* box 42. Sanford worked at the Lincoln School, an experimental school associated with Teachers College where new pedagogical ideas such as projects were tested.

if she had known about projects in the past she could have gotten away with anything, bamboozling her principal with "pedagogical polysyllables."[72] It comes as no surprise that these mathematicians were critical of Kilpatrick's report on math, but their jokes behind his back went beyond this: in denying that his educational philosophy had any basis or deserved respect in any regard, they insinuated that Kilpatrick lacked the authority to comment on math education at all.

What is striking about Snedden and Kilpatrick is the degree to which they agreed on the need to cut back on math teaching despite their opposed philosophies of education. Snedden's industrial approach to education was analytic, breaking down the school experience into smaller and smaller parts with an eye toward extracting as much efficiency as possible from the school. Kilpatrick was instead holistic and naturalistic, trying to unify different aspects of education into a single experience that made sense and was motivating from a student's perspective. They represented opposite extremes of the progressive education movement, one trying to mold children to better fit into society and the other changing the social environment to better accommodate children's needs. Yet they arrived at the same conclusions regarding high school math: most people did not use algebra or geometry in daily life, and the subjects did not discipline children's minds, so they should not be required for students who disliked math. From the mathematicians' perspective, their subject seemed to be under attack from all sides, with no faction of progressive educators speaking out in favor of mathematics.

The Mathematics Community's Response

This hostility from progressives transformed how mathematicians such as Smith went about education reform. In earlier years, math educators were free to discuss the merits of

[72] Letter from Sanford to Smith, n. d., *DES Professional Papers* box 42. Details from the letter indicate that it was written after 1919.

different teaching methodologies or the need to improve teacher training, confident that they would have years or decades to work these issues out. Starting in the mid-1910s, earlier pedagogical discussions took a backseat to the more urgent existential task of securing math's position as a required subject. For the first time, mathematicians had to seriously consider the question of why their subject ought to be taught. They sought justifications outside of mental discipline, arguing that the utilitarian and cultural values of math did enough to justify its place in the curriculum. Internal divisions within the profession became muted as different educators came together against a common external threat. This shift in tone and priorities was a turning point for the math education community, but it is also possible to identify continuities across this period. Mathematicians tried to rearticulate their reform projects of previous decades in ways more amenable to progressive critics, coopting their language and tactics when possible. The late 1910s and early 1920s were a defensive period for math educators during which they scrambled to make sense of their new hostile environment.

As seen in the previous chapter, the favorite organizational tools of the mathematics community were the professional society and the committee. The new national society founded during this period, the National Council of Teachers of Mathematics (NCTM), was intended to organize the nation's high school teachers in defense of the subject. This organization was itself the outgrowth of another, local organization, the Chicago Men's Math Club, which met throughout the 1910s for informal discussions on how to protect their subject against critics.[73] Club members attended a National Education Association meeting held in Chicago in 1919, which was apparently dominated by papers and speeches hostile to mathematics.[74] This spurred them to found the NCTM the following year. The new organization's founders acknowledged

[73] Roberts, "Mathematics and Pedagogy," 364.
[74] C. M. Austin, "Historical Account of Origin and Growth of the National Council of Teachers of Mathematics," *Mathematics Teacher* 21 (1928): 204.

that the university-focused MAA had already begun organizing in defense of school mathematics, but argued that an association of high school teachers would be more appropriate to defend high school math.[75] The NCTM quickly acquired an existing journal *The Mathematics Teacher*, which became an important platform for pro-mathematics articles in the following years. Smith alone published at least a dozen articles in *The Mathematics Teacher* attempting to defend math in some way.[76] The attack on mathematics thus encouraged existing trends toward a unified professionalization and community formation.

The most complete statement in defense of mathematics was the *Reorganization of Mathematics in Secondary Education* report published in 1923 by the National Committee on Mathematical Requirements (NCMR).[77] This committee first met in the summer of 1916, coinciding nicely with the growth of anti-math rhetoric at Teachers College.[78] Alongside Smith, the committee included a mix of research mathematicians such as J. W. Young, E. H. Moore, and H. W. Tyler, as well as high school math teachers such as Vevia Blair, J. A. Foberg, and Raleigh Schorling.[79] The different backgrounds and educational philosophies of these members makes it difficult to place the NCMR ideologically; one gets the sense that they came together out of a sense of urgency rather than for any cohesion of ideas. Moore (who was, indeed, returning to pedagogical issues after a long period of inactivity) spoke to the committee's defensive nature when he characterized two potential members as "successful propagandists for mathematics."[80]

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[75] C. M. Austin, "The National Council of Teachers of Mathematics," *Mathematics Teacher* 14 (1921): 1.
[76] For example: "What Is to Be the Outcome," *MT* 9 (1916): 77-79; "Introductory Course in Mathematics," *MT* 11 (1919): 105-114; "Religio Mathematici," *MT* 14 (1921): 413-426; "The Next Step in Content in Junior High School Mathematics," *MT* 15 (1922): 26-27; "The Call of Mathematics," *MT* 19 (1926): 282-290; "The Poetry of Mathematics," *MT* 19 (1926): 291-296; "Esthetics and Mathematics," *MT* 20 (1927): 419-428. Note the movement away from concrete educational issues to more eclectic subjects. This will be discussed in the next chapter.
[77] *The Reorganization of Mathematics in Secondary Education* (Mathematical Association of America, 1923).
[78] *Reorganization*, vii.
[79] *Reorganization*, v. J. W. Young should not be confused with J. W. A. Young, discussed in the previous chapter.
[80] Letter from Moore to Smith, Nov. 4, 1917, *DES Professional Papers* box 35.

Evidently, a great amount of effort went into the *Reorganization* report, given the seven years between the committee's founding and the publication and the massive length of the report at over 600 pages. These details make the *Reorganization of Mathematics in Secondary Education* a useful object of study as the math education community's definitive statement of purpose of the early 1920s.

On the one hand, the report reflected the weakened position of math educators, whose goals had become much less ambitious during the crisis period. Most strikingly, the report claimed that the essentials of the math curriculum could be completed by the end of grade nine, with further math classes as electives.[81] This was the same conclusion Kilpatrick reached in his CRSE report of 1920 and would seem to be an odd choice for those trying to defend high school mathematics.[82] The mathematician-led NCMR differed from Kilpatrick's committee in its attitude toward this elective math, arguing that "every standard high school [as opposed to vocational schools] should not merely offer courses in mathematics for the tenth, eleventh, and twelfth years, but should encourage a large proportion of its pupils to take them."[83] The committee gave no clarification on what this encouragement would look like; all that distinguished it from Kilpatrick's suggestion was a vague difference in attitude. In other areas, the committee was hesitant to make any definite recommendation at all, hoping to avoid alienating skeptical teachers by remaining general. After discussing the advantages of correlating different areas of math into a unified course, as suggested by Chicago reformers such as Moore, the report retreated and admitted that perhaps correlation was not the best option, as "a large number of high schools will for some time continue to find it desirable to organize their courses

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[81] *Reorganization*, 14. Depending on the school, this would correspond either with the end of junior high school or with the midpoint of a seventh-twelfth grade secondary school. The JHS model became more dominant as time went on.
[82] *Problem of Mathematics*, 23.
[83] *Reorganization*, 32.

of study in mathematics by subjects."[84] Moore's laboratory method, which had seemed like a promising way to correlate math class, did not appear by name anywhere in the report. Organize however you like, the committee seemed to say, as long as math requirements stay. These rhetorical choices reveal a weakened bargaining position and a desperation to preserve math's place in the curriculum to any extent possible.

But the *Reorganization* report was also an attempt to beat progressives at their own game, using the logic of efficiency and child interest in support of math rather than against it. It began by defining the various aims of math education, echoing Snedden's preoccupation with educational goals. Snedden saw vocational preparation as the only goal of high school math; the NCMR responded with a longer list of goals that played up math's social importance. It broadly categorized these as practical aims (mostly dealing with daily life as opposed to specific vocations), disciplinary aims (insisting that it was taking a more moderate position than nineteenth century disciplinarians), and cultural aims (which will be discussed in more detail in the next chapter).[85] With this expanded framing, math appeared not as a tool for the restricted use of scientists and engineers but as a broadly-applicable aspect of human life and culture. The report also emphasized earlier reform ideas that were more in alignment with progressive rhetoric. It suggested that geometry be split into two classes: a required course in "intuitive geometry," teaching measurement by ruler, formulas for areas and volumes, and the basic properties of triangles, followed by an elective course in traditional Euclidean proofs.[86] This model of introducing geometry through observation and concrete application had long been a popular idea among mathematicians, having been supported by the IMUK commissioners in

[84] *Reorganization*, 13.
[85] *Reorganization*, 6-11.
[86] *Reorganization*, 11, 22-23.

1912.[87] Moreover, the privileging of concrete applications over abstract proof was also a concern of progressives, who spoke of shifting from "logical" to "psychological" organization and "learning by doing"; one can imagine the NCMR members stressing intuitive geometry as a way to appeal to hostile progressives.

One of the most interesting ideas advocated by the NCMR, so important that it received its own chapter in the report, was the "function concept." By this, the committee meant "the idea of relationship between variable quantities as one of the general ideas that should dominate instruction in elementary mathematics."[88] The authors were careful to point out that they did not mean any specific definition of the function or manipulation of the *f(x)* notation, but simply the broad idea of relationship and its application to many specific instances. Again, this was a long-discussed proposal among math educators, introduced at least as early as 1893 by Felix Klein as part of his program of unifying modern mathematics.[89] The idea was that students could be exposed to the notion of relationship in a variety of circumstances—formulas for area and volume, the congruence of geometric figures, proportion, trigonometric functions, and the representation of these concepts through graphs or numerical tables—realize that a single concept underlies all of them, and apply the function concept to real-life situations such as taxation, cooking recipes, or monetary interest.[90] The choice to stress a single concept so strongly, going so far as to claim that "all students will be better able to control the actual relationships which they meet in their own lives," is peculiar; it can be seen as another attempt to appropriate progressive logic in service of math, this time appealing to both the social efficiency

[87] *Report of the American Commissioners*, 19.
[88] *Reorganization,* 64.
[89] Felix Klein, "The Present State of Mathematics," in *Mathematical Papers Read at the International Mathematical Congress Held in Conjunction with the World's Columbian Exposition Chicago 1893*, ed. Moore et al. (New York: Macmillan & Co., 1896), 134.
[90] *Reorganization,* 65-72.

and child-centric camps.[91] The inclusion of various real-world applications of math could placate vocationally-minded progressives such as Snedden, while the holism and anti-formalism of the function concept bears more resemblance to Kilpatrick's thinking. The mathematicians' description of the unifying function concept bears a noticeable similarity to Kilpatrick's description of his project method: "I had felt increasingly the need of unifying more completely a number of important related aspects of the educational process. I began to hope for some concept which might serve this end."[92] The NCMR thus represented an attempt to meet progressives on their own terms, demonstrating that the language of psychological pedagogy could be mobilized in defense of mathematics.

Mathematicians did much to publicize the NCMR and its report over the following years. The committee aggressively distributed copies of the report throughout the public school system; within a few years the original run of 25,000 copies was exhausted and a reprint was published.[93] In a 1926 summary of recent progress in high school math teaching, Smith claimed that the committee was "too well-known for detailed remarks" and that "the advance in the teaching of mathematics in our secondary schools in the last decade has been due in large part to the work of this committee."[94] This extravagant praise seems undeserved just three years after the report's publication. It is difficult to find an enthusiastic reaction to report outside of the mathematical community: Harold Rugg, a Teachers College professor, dismissed the committee's conclusions as the subjective opinions of a few experts and contrasted it with the more "objective"

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91 *Reorganization,* 73.
92 Kilpatrick, *Project Method*, 3.
93 Roberts, "Mathematics and Pedagogy," 388.
94 David E. Smith, "A General Survey of the Progress of Mathematics in Our High Schools in the Last Twenty-Five Years," in *National Council of Teachers of Mathematics Yearbook* 1 (1926): 8-9.

psychological studies on math education conducted by Thorndike.[95] Even after hundreds of pages had been written by both sides, the fundamental disagreement remained: mathematicians saw themselves as authoritative because of their expert knowledge, while progressives valued general, "objective" knowledge. The actions of the NCMR members are understandable, as they saw themselves as "propagandists" for math and felt compelled to exaggerate the report's importance, but the broader educational community proved unresponsive.

This stands in contrast to the effectiveness on the attack on mathematics and its impact over the next several decades. Enrollments in high school algebra and geometry, which had been increasing since the end of the nineteenth century, began to drop. In 1900, 56% of American students were enrolled in an algebra class, up from 45% in 1890; this dropped to 40% in 1922, then 30% in 1934, then just 27% in 1949. Enrollments in geometry followed a similar trend.[96] School districts accepted the arguments of progressive pedagogists and stopped requiring math for high school graduation; students, evidently discouraged by the uninteresting, overly-disciplinarian math classes still being taught in most high schools, largely abandoned the subject. Kilpatrick and Snedden were not primarily interested in math education, which only figures in a small fraction of their writings, yet their criticism of math had real effects for decades afterward. While mathematicians continued to proselytize their subject into the 1920s and 1930s, it should be kept in mind that they ultimately failed to get more students into math classrooms.

Smith retired from teaching in 1926, but continued his leading role in the math education community almost until his death in 1944.[97] During this last phase of his career, Smith absorbed the lessons of the progressive attack on math and attempted a broader reconfiguration of the

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[95] Harold Rugg, "Curriculum Making: What Shall Constitute the Procedure of National Committees?" *Mathematics Teacher* 17 (1924): 2.
[96] Kliebard, *Struggle*, 225-226.
[97] Letter from Smith to Russell, Nov. 7, 1925, *DES Professional Papers* box 41.

American public's relationship with mathematics. It had become clear that many Americans failed to see any value in mathematics beyond its utilitarian use in a narrow range of professions, and that this alienation made math education vulnerable to the attacks of radical progressives. In the 1920s and 1930s, Smith shifted his focus away from the formal education of schools and universities and toward a broader notion of popular education accessed through books and articles, public lectures, and radio broadcasts. Through this project of broad popularization, he articulated a vision of mathematics that had humanistic value, as opposed to the outdated disciplinary value of the nineteenth century and the purely utilitarian value advocated by many progressives. The following chapter will explore the different ways Smith pursued this goal and the network of similarly-minded humanists that gathered around him.

The Historical-Humanistic Mathematics Community

In the National Committee on Mathematical Requirements' *Reorganization* report of 1923, the authors identified three aims in math education that could justify the subject's value to students: practical aims, disciplinary aims, and cultural aims. With Thorndike's psychology research and its acceptance among progressive educators, mental discipline ceased to be a useful justification for teaching math. Practical and utilitarian aims were the favorite justification of efficiency-minded progressive educators; math educators, by contrast, tended to believe that reducing their subject to a mere pragmatic tool did not fully capture its importance. This left cultural value as the best tool mathematicians could use to justify the subject's importance in the required school curriculum. Through the 1920s and 1930s, David Eugene Smith and his professional allies tried to convince the public of mathematics' humanistic value by identifying connections between mathematics and different areas of human culture. Their main tool was the history of mathematics, but the philosophy and aesthetics of mathematics were also frequently put to strategic use.

This chapter will narrate this defense of mathematics via its cultural value and the emergence of a new history of math community. The progressive attack on mathematics, discussed in chapter two, provided the motivation for this move: articulating a multitude of values associated with mathematics served as a defense of the subject's place in the required curriculum. The growing community of professional math educators, discussed in chapter one, provided the manpower for this defense. The scholars who wrote the history of mathematics did not come from a historical background, but were trained as mathematicians and were embedded in the professional infrastructure that by this point was highly organized and widespread. Smith remains the key figure here: his position at Teachers College gave him a close knowledge of progressive arguments, while his high place within the math education community gave him the social capital needed to mobilize his colleagues into his strategy of defense. The last decades of Smith's career saw the definition and consolidation of the history of mathematics as a discipline, just as research mathematics and math education had emerged in earlier years.

Studying the History of Mathematics before the Crisis

The formal study of the history of mathematics in America extends back at least to 1890, well before Kilpatrick or his progressive colleagues began attacking school math requirements. During this early period, history and math education were closely linked, as educators understood the subject's history as an easy way to stimulate students' interest in math. However, it is difficult to identify any particular goal beyond this or any unifying vision for what the history of math should look like. Up until the mid-1910s, the history of math was written by a few scattered math educators who saw it as a minor supplement to their classroom work. This period provides a sharp contrast with the transformation in history writing that would occur with the progressive attack on mathematics.

While Smith dominated America's study of the history of math, the first American mathematician to dedicate a significant portion of his career the subject was probably Florian Cajori. His earliest work, a history of mathematics in the U. S., reflects the inchoate state of math history in this period.[1] The work was commissioned by the federal government's bureau of education and was clearly understood as relevant to math education, but it did not explain exactly what that connection was. Cajori did not even write an introduction explaining his motivation for

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[1] Florian Cajori, *The Teaching and History of Mathematics in the United States* (Washington: Government Printing Office, 1890).

the work; a short note by Commissioner of Education N. H. R. Dawson merely stated that the work "will prove of great value to all teachers and students of mathematics."[2] Other early writings exhibit a similar lack of vision: a short biography of Gauss and his family or a quick note hypothesizing that the symbol for zero could have originated in China lacked any justification aside from being of interest to the science- or math-focused journals in which they were published.[3] While Cajori continued writing on the history of math until his death in 1930, he was not central to the process of community-formation in the way Smith was. This was largely a matter of geography: Cajori spent his career first at Colorado College and then at the University of California, many hundreds of miles from other historians of math. This cut him off from those areas of professional activity that require face-to-face communication, such as taking on Ph.D. students or giving public lectures. Because of this, Cajori will not figure prominently in the latter part of this chapter dealing with the formation of the history of math as a discipline.

Smith became interested in the history of math soon after Cajori, and his early writings exhibited a similar lack of direction beyond a vague affinity with math education. His earliest works, such as a translation of some of Felix Klein's historical writing or the historical notes scattered through his early textbooks (see chapter 1), were not themselves original historical research.[4] The introduction to his geometry textbook noted that historical notes were "designed to increase the interest of the student," mirroring Cajori's restricted understanding of what role history could play in the math curriculum.[5] Also significant in this phase of Smith's career is an early notion of math's cultural value, not yet fleshed out as a defense of math education. In a

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[2] Cajori, *Teaching and History*, 5.
[3] Florian Cajori, "Carl Friedrich Gauss and His Children," *Science* 9 (1899): 697-704; Florian Cajori, "On the Chinese Origin of the Symbol for Zero," *American Mathematical Monthly* 10 (1903): 35.
[4] David Eugene Smith, "Historical Survey of the Attempts at the Computation of π," *American Mathematical Monthly* 2 (1895): 348-351.
[5] Wooster Woodruff Beman and David Eugene Smith, *Plane and Solid Geometry* (Boston: Ginn & Co., 1896), iv.

guide to math teaching first published in 1900, Smith identified the two goals of math education as utility and culture, the latter of which included logical training and the mathematical connections to religion, ethics, and philosophy.[6] This identification of distinct goals anticipated the NCMR report's division of practical, disciplinary, and cultural aims, but in a less-developed form. It is striking, for example, how little history figures in Smith's early discussion of cultural goals; instead, his focus is on math's ability to "train the mind of the child logically to attack the every-day problems of life."[7] This description bears some resemblance to nineteenth-century mental discipline, which Smith did not mention by name. In 1923, mental discipline was an unpopular concept, so the NCMR decided to address it head-on and discuss its relevance to math education; in 1900, mental discipline was taken for granted and Smith had no reason to mention it. The progressive attack on mental discipline thus helped to clarify and focus Smith's earlier conceptions of math's cultural value.

A turning point in Smith's historical career came in 1901 with his appointment to Teachers College and move to New York City. This coincided with greater access to primary sources and a more research-oriented relationship to the history of mathematics. Smith's close friend, the publisher and businessman George Arthur Plimpton, had collected a huge library of historical books and manuscripts related to education.[8] Sometime before 1901, as Plimpton recollected in a private letter of 1933, Smith visited this collection and decided to move to New York to do historical work with these sources.[9] Plimpton's sources were the basis on which America's study of the history of math was built: Smith's first major original historical work,

[6] David Eugene Smith, *The Teaching of Elementary Mathematics* (New York: Macmillan Company, 1906), 20.
[7] Smith, *Teaching of Elementary Mathematics*, 26.
[8] Plimpton's publishing company, Ginn & Co., was a major textbook publisher and appears often in these footnotes.
[9] Letter from Plimpton to Smith, Jan. 19, 1933, *David Eugene Smith (DES) Professional Papers* box 39. It is unclear exactly when and how these two met, as they were already friendly in their first preserved letter of 1892.

Rara Arithmetica, was itself a catalogue of the early arithmetic texts in Plimpton's library.[10] Smith also took an interest in collecting historical documents, gathering a personal library of over 10,000 books and instruments that he donated to Columbia's library in 1931.[11] In these two libraries, America had a definite site for producing knowledge of the history of mathematics for the first time. Smith, centrally located in this network, had the power to influence the growth of this field to better align with his own professional goals, which became starkly clear once math requirements were threatened.

Propagandizing Mathematics in the 1910s and 1920s

While these early writings on the history of mathematics were often integrated into math education, they were not made explicitly in defense of math education. With the progressive attack on mathematics, the function of Smith's history writing changed from making math classes more interesting to justifying math's place in the classroom. This period also saw significant growth in the number of historians of mathematics, as Smith actively recruited young math educators into historical writing. These trends should be considered an extension of the strategic thinking discussed previously in connection with the NCMR report, made with the explicit goal of shoring up math's position in the schools. In bringing together math educators in this shared project, Smith laid the foundations for a community distinct from the math education establishment from which it emerged. While most historians of math remained professional math educators, I will here treat the two as separate disciplines: historians of math eventually struggled to establish institutions outside of the math education community, speaking to a need to establish

[10] David Eugene Smith, *Rara Arithmetica: A Catalogue of the Arithmetics Written before the Year MDCI with a Description of Those in the Library of George Arthur Plimpton of New York* (Boston: Ginn & Co., 1908).
[11] *David Eugene Smith Historical Papers*, Rare Book and Manuscript Library, Columbia University. More information is available at https://clio.columbia.edu/catalog/4079344.

their own unique place in academia. This was a process of communal self-identification that involved conflict in working out who was inside and who was outside of the community.

This shift toward justifying math is most clearly visible in Smith's articles of the 1920s, which covered an eclectic mix of topics and their connections to mathematics. One article compared math and poetry, stressing that both attempt to communicate lots of information in a small amount of space and pursue the truth in different ways.[12] The next year he published a similar article on mathematics and aesthetics, giving examples of ratio and pattern that appear in architecture and in nature.[13] Soon after this he returned to the function concept stressed so heavily in the NCMR report of 1923, applying it to the social life of children studying math: "You depend upon your friend for good company, for encouragement, for honest counsel, and for help; but in each case your friend also depends upon you. [...] There is no such thing as a perfectly independent variable in your action or in his, nor is there such a thing as perfect independence."[14] Like his more conventional historical research, this broad-ranging series of articles must be considered in the context of Smith's educational vision. Without exception, they were published in *Mathematics Teacher* and so were aimed at America's high school teachers, providing them with material that could enliven the math classroom. If mathematics could clarify the meaning of high art and daily life, Smith implied, then surely it was not a merely utilitarian tool needed by a narrow range of students.

The best example of this genre of writing is "Religio Mathematici," an address delivered at a 1921 MAA meeting and subsequently published in the association's journal, the *American*

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[12] David Eugene Smith, "The Poetry of Mathematics," *Mathematics Teacher* 19 (1926): 291-296.
[13] David Eugene Smith, "Esthetics and Mathematics," *Mathematics Teacher* 20 (1927): 419-428.
[14] David Eugene Smith, "The Lesson of Dependence," *Mathematics Teacher* 21 (1928): 216.

Mathematical Monthly (*MAA*).[15] Smith's goal was to identify the relationship between mathematics and religious sentiment to put faith on a stronger foundation. He claimed that mathematics is one of the few places where a person has access to immortality, as mathematical laws hold true regardless of when they are written or what notation is used.[16] Math forces students to try to comprehend infinity, for example when learning that there are an infinite number of points on a line segment.[17] These religious ideas accessed via mathematics led Smith to consider a "duality of mathematics and religion" which he considered analogous to the interrelation of space and time in special relativity.[18] Without advocating any particular religion, Smith concluded that mathematics simply "increases the faith of a man who has faith" and encourages the humility necessary in religion.[19] Finally, Smith returned to his favorite topic of education: in light of the religious nature of mathematics, the teacher should not simply teach the subject as a set of unrelated rules and facts (or worse, as something to be memorized because it will appear on a test), but as a source of beauty and a point of entry to eternal truth.[20]

"Religio Mathematici" received a stronger response than any of Smith's other articles. Smith's obituary in *Mathematics Teacher* identified the address as "famous" among his many works; the obituary in the *AMM* claimed that it "reveals with great clearness the depth and richness of his religious feeling."[21] Smith's colleague C. J. Keyser of Columbia called it "brave, penetrating, Catholic, spiritual—and will do more good in the world than a thousand addresses of

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[15] David Eugene Smith, "Religio Mathematici," *American Mathematical Monthly* 28 (1921): 339-349.
[16] Smith, "Religio," 341.
[17] Smith, "Religio," 343.
[18] Smith, "Religio," 347. Smith referred to relativity as the "Minkowski-Einstein hypothesis" and likely understood the mathematics underlying spacetime.
[19] Smith, "Religio," 348.
[20] Smith, "Religio," 348.
[21] William D. Reeve, "Editorial," *Mathematics Teacher* 37 (1944): 278-279; W. Benjamin Fite, "David Eugene Smith," *American Mathematical Monthly* 52 (1945): 237-238.

the ordinary technical kind whether 'scientific' or 'pedagogic.'"[22] Keyser's comments reveal the strategic nature of Smith's address, painting it as an effective alternative approach to math pedagogy. Raymond Clare Archibald of Brown University, then editor-in-chief of the *AMM* and another mathematician who studied the history of the subject, called it "beautiful in concept and form," promised to publish it in the journal, and allowed Smith to republish it in any journal he wished—an unusual gesture of kindness.[23] "Religio" did indeed appear in *Mathematics Teacher* a few months later, dispersing Smith's ideas to a wider audience.[24] It is significant that other math educators saw value in Smith's writings, propagandizing his address rather than dismissing it as a distraction from "serious" discuss of research or pedagogy. These mathematicians shared the goal of defending their subject and saw "Religio" as part of this defense.

Other scholars joined Smith's project, mobilizing humanistic ideas in defense of mathematics. These were mostly younger math educators who, through their personal association with Smith, developed an interest in the history of math and began writing historical material to supplement math education. Interestingly, many of these younger historians came from marginal backgrounds in the mathematical world, which was dominated by native-born Protestant men. For those who lacked any of these characteristics, a research position at a mainstream university was often out of the question; with their options restricted, working with Smith provided an alternative path into professional work. Smith's motives, on the other hand, should not be considered as simply altruistic: given the pressing need to defend math's cultural value, it was to his advantage to recruit as many math historians as possible; women and Jews happened to be a

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[22] Letter from Keyser to Smith, Jan. 24, 1922, *DES Professional Papers* box 29. Underline in original. Presumably, Keyser here used "catholic" to mean "universal" or "cosmopolitan," rather than in reference to the Roman Catholic Church.

[23] Letter from Archibald to Smith, Sept. 14, 1921, *DES Professional Papers* box 2.

[24] David Eugene Smith, "Religio Mathematici," *Mathematics Teacher* 14 (1921): 413-426. As far as I know this is the only article by Smith to appear in two separate journals during his lifetime.

useful source of historical workers. This hierarchical relationship was reinforced by Smith's control of the primary sources needed to write the history of mathematics through his and Plimpton's extensive libraries. For these reasons, the formation of the history of mathematics as an autonomous discipline was concentrated to an unusual degree in the person of David Eugene Smith.

Among the young mathematicians recruited by Smith, his closest friend and protege was Jekuthiel Ginsburg. Ginsburg was a Jewish immigrant from Russia who arrived in New York in 1912.[25] There, he reached out to local mathematics educators, looking for professional guidance and feedback on his mathematical work. Ginsburg first contacted Smith in November of 1915, asking him to evaluate a treatise on elementary geometry.[26] The correspondence between the two grew into a partnership that lasted several decades, with Ginsburg assisting Smith's historical research or co-writing books and articles with him.[27] Smith's partiality for Ginsburg was illustrated through many instances of professional and personal assistance: in 1917 he arranged a fellowship for Ginsburg through Teachers College; in 1918 he helped Ginsburg navigate the military bureaucracy and avoid serving in the army; and in 1921 he offered Ginsburg a loan as the rest of his family emigrated from Europe.[28] Compared with Smith's relationship with William Betz, discussed in the first chapter, the help Smith offered Ginsburg was much more involved and extended further into personal matters typically considered beyond the professional

[25] "Statement of Mr. Ginsburg," July 1, 1918, *DES Professional Papers* box 19. Ginsburg was asked to provide his personal information and educational history as part of the arrangement for his fellowship. This document is the best source on Ginsburg's early life that I have found. He listed his birthplace as Volhynia, a region straddling the border of modern Ukraine and Poland, but described his family as Russian and indicated his native language as Russian.

[26] Letter from Ginsburg to Smith, Nov. 8, 1915, *DES Professional Papers* box 19. These early letters from Ginsburg were written on graph paper rather than professional stationery, indicating his status as a student.

[27] David E. Smith and Jekuthiel Ginsburg, "Rabbi Ben Ezra and the Hindu-Arabic Problem," *American Mathematical Monthly* 25 (1918): 99-108; David E. Smith and Jekuthiel Ginsburg, *A History of Mathematics in America before 1900* (Chicago: Open Court Publishing, 1934); David E. Smith and Jekuthiel Ginsburg, *Numbers and Numerals* (New York: Teachers College, 1937).

[28] Letters of June 29, 1917, Aug. 30, 1918, and Sept. 21, 1921, *DES Professional Papers* box 19.

world. By 1928, only a decade and a half after arriving in the country, Ginsburg had a faculty position at Yeshiva College (now Yeshiva University), a Jewish institution not far from Teachers College. This smooth rise through the academic world was made possible by Smith's relationship as friend and advisor.

Ginsburg showed an early interest in the issues of public outreach and propagandizing math that would dominate the last phase of Smith's career. A letter he wrote in 1916 to J. Ernest G. Yalden, superintendent of a trade school in New York, best illustrates his views on how students ought to be recruited into mathematics.[29] Ginsburg approached Yalden with a proposal for a new periodical aimed at college students. He explained that the existing periodicals, such as the *Bulletin of the American Mathematical Society* or the *American Mathematical Monthly*, covered topics that "may be interesting—and that not always—for a reader who is already a lover of mathematics but nothing of that material is of a nature that can attract the student with abilities and make him a lover of mathematics."[30] The monthly journal Ginsburg envisioned would cover the history of mathematical topics, interesting math problems at a student level, puzzles and games, little-known anecdotes about famous mathematicians, and news about mathematical clubs and societies from around the country, all designed to raise students' interest in mathematics and bring them into the mathematical community. It is striking that Ginsburg became interested in the need to strategize math teaching to better appeal to students so early in his career, without Smith's close awareness of Teachers College progressivism. However, there was an important difference in their thinking: while Smith aimed his writing at teachers, who would then bring the material into classrooms, Ginsburg saw the issue from a student's

[29] Letter from Ginsburg to Yalden, July 1, 1916, *DES Professional Papers* box 19. Despite Smith not taking part in this conversation, this letter somehow made its way into his personal papers. There is no record of Yalden's response to Ginsburg, but clearly he held onto the letter long enough to give it to Smith.
[30] The MAA was being founded around the same time Ginsburg wrote to Yalden, but its journal, the *AMM*, had been published for several years before then.

perspective and planned ways to reach out to students directly. Of course, his journal proposal was impractical—neither he nor Yalden had any experience in publishing, and the two did not seem to discuss the idea further—but this approach to mathematical outreach would inform Ginsburg's later career.

Ginsburg was Smith's closest protege, but a few other math historians fit a similar pattern of recruitment by Smith. A surprising number of these were women. Teaching was and is a gendered profession, and many of the students Smith taught at Teachers College were young women intending to become math teachers in elementary or high schools.[31] Examples of this include Vera Sanford and Helen Walker, who began publishing articles on the history of math, in addition to more conventional discussions of math education, in the 1920s.[32] Lao Genevra Simons, who taught at Hunter College (called Normal College until 1914), then an all-female school of education within the City University of New York, provides a good example. Simons was born in 1870 and was thus already well-established in her career by the time she befriended Smith.[33] However, Smith still ended up playing the role of mentor and professional guide for two reasons: first because Simons was taking classes at Teachers College well into the 1920s and played the role of Smith's student despite their similar ages, and second because she was a woman teaching at a women's college who held a lower professional status than Smith.[34] Smith had several opportunities to advance Simons through the professional world, inviting her to serve

[31] *A History of Teachers College* discusses the demographics of the school's students in detail but, strangely, does not give a definite explanation of the school's gender balance. The most specific description is that the earliest students at Teachers College were "young girls," who were largely replaced by "older students" by the 1920s. Lawrence Cremin, *A History of Teachers College, Columbia University* (New York: Columbia University Press, 1954), 115-116.

[32] Vera Sanford, "La Disme of Simon Steven—The First Book on Decimals," *Mathematics Teacher* 14 (1921): 321-333; Helen M. Walker, "The Relation of Plana and Bravais to Theory of Correlation," *Isis* 10 (1928): 466-484.

[33] "Obituaries," *Isis* 41 (1950): 202.

[34] Simons began teaching around 1890 (letter of Jan. 19, 1904, *DES Professional Papers* box 45), at which point she would have been roughly 20 years old. Her decision to return to graduate study later in her life is not surprising given the professionalization of teaching over the early twentieth century.

on an IMUK subcommittee on elementary school teacher training and writing a letter of recommendation when she applied for promotion.[35] Simons, beginning in the 1920s, wrote on mathematics in 18th century America and argued that more historical material should be brought into the math classroom.[36] She taught a class on the history of mathematics, bringing her students on field trips to Smith's mathematical library.[37] In other words, after Smith used his influence to advance these women's careers, they emulated his approach to education and history, adding their voices to the defense of school mathematics.

The last major member of Smith's circle of disciples was the professor of mathematics Louis Karpinski. Karpinski spent the 1909-1910 school year as a fellow at Teachers College, where he gained an interest in the history of mathematics from Smith.[38] Karpinski evidently made a good impression, as Smith recommended him to W. W. Beman, his partner in textbook-writing from the 1890s, for an assistant professorship at the University of Michigan.[39] It is doubtful whether Karpinski should be considered marginalized, but he clearly had trouble advancing through the academic world: from 1913 to 1926 he regularly asked Smith for letters of recommendation, ultimately remaining in Michigan's math department for the rest of his career.[40] The help Smith could offer was in historical research: the two co-authored a book on Hindu-Arabic numerals early in their relationship, and sources in the Smith and Plimpton

[35] Letters of June 11, 1909, and Apr. 2, 1920, *DES Professional Papers* box 45.
[36] Lao G. Simons, "The Place of the History of and Recreations of Mathematics in Teaching Algebra and Geometry," *Mathematics Teacher* 16 (1923): 94-101. For an example of her historical research, see "Algebra at Harvard College in 1730," *American Mathematical Monthly* 32 (1925): 63-70.
[37] Letter from Simons to Smith, Dec. 19, 1926, *DES Professional Papers* box 45.
[38] Phillip S. Jones, "Louis C. Karpinski," *Science* 124 (1956), 19.
[39] Letter from Beman to Smith, Jan. 28, 1910, *DES Professional Papers* box 4.
[40] Letters from Karpinski to Smith of Nov. 4, 1913; Dec. 21, 1915; Apr. 22, 1916; Jan. 24, 1917; Oct. 2, 1917; and Apr. 10, 1926, *DES Professional Papers* box 28.

libraries provided material for Karpinski's later research.[41] In turn, Karpinski adopted Smith's stance on math's cultural value, arguing against the vocationalization of high school mathematics and claiming that math was as much a part of our cultural heritage as literature or history.[42] His writing on Babylonian mathematics provides an example of how Karpinski applied these ideas in his historical writing: he claimed that recent discoveries of ancient Babylonian mathematical achievements, revealed "the underlying cultural relationship of these older civilizations to the civilization of our day, and equally to the later civilizations of the Mediterranean area."[43] This was a radical claim, establishing a continuity between the relatively little-known Babylon and the legendary achievements of Greece and Rome on the basis of their mathematical understandings. In all of these young math historians we see the same pattern of exchange: Smith provided help with academic advancement and source material for history, and in return his students echoed his vision of math's cultural value and place in the required curriculum.

Karpinski is also important as an example of how this process of reciprocal community-formation could be disrupted by personal arguments and accusations of professional misconduct. In early 1927, Smith insinuated that some of Karpinski's research on the early history of the Pythagorean theorem was sloppy; Karpinski took this criticism poorly, demanding that Smith retract his insinuation and refusing to apologize for his research.[44] An intellectual community requires the possibility of critique to function normally, but the line between legitimate criticism and personal attack is contestable. Karpinski's last letter to Smith for several years was unusually

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[41] David E. Smith and Louis Karpinski, *The Hindu-Arabic Numerals* (Boston: Ginn & Co., 1911). Louis C. Karpinski, "The First Printed Arithmetic of Spain: Francesch Sanct Climent," *Osiris* 1 (1936): 411-420.

[42] Louis C. Karpinski, "The Permanent Nature of the Necessity for Mathematics in the Secondary Schools," *Mathematics Teacher* 22 (1929): 197-202.

[43] Louis C. Karpinski, "New Light on Babylonian Mathematics," *American Journal of Semitic Languages and Literatures* 52 (1936): 74.

[44] Letter from Karpinski to Smith, May 2, 1927. I have not found Smith's original claim against Karpinski, and so the exact details of Karpinski's grievance are unclear.

abrupt, consisting only of the sentence "Why did you feel it necessary to hide your authorship of the review of my History of Arithmetic by having it appear unsigned?"[45] Anonymous reviews are common in academic journals, but Karpinski evidently saw an unsigned critique from a colleague of over 15 years as a breach of trust. Both Karpinski and Smith had spent decades in academia and must have developed some understanding of what behavior is proper in a review, but this community was different in its small size: it was not clear that anonymity would continue to be an appropriate norm if everyone already knew each other. The situation was eventually resolved in 1931, when their mutual friend G. A. Plimpton arranged a meeting between the two.[46] The small size of the historical community meant that personal disputes could be unusually disruptive, but it also meant that face-to-face discussion and reconciliation played a larger role in keeping the group together than would be the case in larger communities.

Beyond this immediate network was an international group of mathematical historians on the periphery of Smith's educational project. Smith kept up correspondence with many mathematicians and math historians outside the U. S., unsurprisingly given his leading role in the IMUK. Europeans such as Gino Loria in Italy, George Greenhill in Britain, and Gustav Eneström in Sweden began studying the history of math before the discipline emerged in the U. S.; Smith interacted with them as professional equals. More surprising are several Asian historians of mathematics for whom Smith played the role of intermediary with American readers. Yoshio Mikami, one of the first Japanese people to study the history of mathematics in his own country, co-wrote a book on Japanese mathematics with Smith.[47] This work, one of Smith's most well-

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[45] Letter from Karpinski to Smith, Oct. 24, 1927.

[46] Letter from Karpinski to Plimpton, Apr. 25, 1931, *DES Professional Papers* box 28.

[47] David Eugene Smith and Yoshio Mikami, *A History of Japanese Mathematics* (Chicago: Open Court Publishing, 1914). Mikami's name is here given in the Western order of given name followed by family name, as this was what he used in his English-language writings. The Japanese order, Mikami Yoshio, is more common in contemporary publications.

known, helped introduce East Asian mathematics to the English-speaking world and, in the words of Karpinski's review, "will contribute to a juster and broader appreciation of the Japanese genius."[48] In return for this propagandizing, Mikami contributed information on the state of Japanese math education to American periodicals.[49] Smith also kept in touch with Indian historians such as Avadhesh Narayan Singh and Sarada Kanta Ganguli. The early twentieth century saw a renewed appreciation for India's contributions to early mathematics (recall Karpinski's and Smith's work on Hindu-Arabic numerals, which would have simply been called Arabic numerals a few decades earlier), and these Indian historians contributed to this through their writings in English. Singh co-wrote a *History of Hindu Mathematics*, which he asked Smith to review for an American periodical.[50] Ganguli contributed articles on Indian mathematics to the *American Mathematical Monthly* and thanked Smith for his "sympathy for India and Indians."[51] Comments such as these suggest that Smith was providing some kind of service, raising awareness of Asians cultures among a largely ignorant American readership; what he received in return was a broader variety of historical writing to appeal to students' interest, capitalizing on the mystique of an exotic, mysterious Orient that Americans associated with East and South Asia.

All the mathematicians discussed thus far were to some degree on board with Smith's project to align the study of math's history with the subject's educational needs. George Abram Miller of the University of Illinois provides a useful example of a historian of mathematics with conflicting priorities who thus had a hard time participating in the community. Unlike his

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48 L. C. Karpinski, review of *A History of Japanese Mathematics*, *American Mathematical Monthly* 21 (1914): 152. The early twentieth century was Japan's period of intense modernization and industrialization, and Mikami's portrayal of indigenous Japanese mathematics fits into a broader context of demonstrating to the West how "civilized" the country had become.

49 Yoshio Mikami, "The Teaching of Mathematics in Japan," *American Mathematical Monthly* 18 (1911): 123-134.

50 Letter from Singh to Smith, Oct. 22, 1935, *DES Professional Papers* box 45.

51 Letter from Ganguli to Smith, Oct. 6, 1926, *DES Professional Papers* box 18.

contemporaries, Miller entered history via research mathematics and was not central to the ongoing conversation on math education; during his life, he was best known as a pioneer of group theory.[52] His fame as a researcher contrasts with his notoriety among math historians, who critiqued his pedantic writing style in their private communications. In particular, his book reviews were extremely critical, exhaustively detailing the factual mistakes in the work: in his 1923 review of Smith's book on Greek and Roman mathematics, Miller gives 14 separate page citations of Smith's mistakes, complaining that "the reader who is mainly interested in actual facts relating to the contributions by the Greeks and Romans might sometimes wish that our author had not made such free use of the hyperbole."[53] In response to such reviews, Archibald claimed that "he has long deserved a good drubbing;" C. J. Keyser called him a "savior-critic," making fun of his self-importance; and Ginsburg called his work "unscientific," complaining that the errors Miller identified tended not to be errors at all.[54]

Miller's alienation from the history of mathematics community was not simply an issue of personality and combativeness but was rather the result of competing professional goals. In a series of letters in late 1923, Miller and Smith finally addressed their differences. Smith explained that Miller's obsession with factual errors came off as rude and violated general expectations of professional behavior. One sentence in particular points to Smith's broader goal in trying to enforce norms of civility: speaking of a book by Cajori that Miller had criticized, he claimed that "it is a helpful book for students in spite of its faults, and this much could generously be said of it."[55] For Smith, review writing was one aspect of the educational project

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[52] H. R. Brahana, "George Abram Miller," *American Mathematical Monthly* 58 (1951): 447-449.
[53] G. A. Miller, review of *Mathematics: Our Debt to Greece and Rome, Science* 58 (1923): 288-290.
[54] Letters from Archibald to Smith, Oct. 25, 1923, *DES Professional Papers* box 2; from Keyser to Smith, Nov. 15, 1923, *DES Professional Papers* box 29; and from Ginsburg to Smith, Oct. 30, 1925, *DES Professional Papers* box 19.
[55] Letter from Smith to Miller, Dec. 19, 1923, *DES Professional Papers* box 34.

of instilling an interest in math among students; Miller's reviews did not serve that goal and thus deserved criticism. Miller responded by presenting himself as an objective researcher, undistracted by secondary concerns: "these personal matters are, however, of little moment as you know, but the actual historic facts interest me."[56] "Actual historic facts" were, of course, important to Smith as well, and this disagreement should not imply that Smith was ready to deliberately tell falsehoods in service of math education. The episode merely demonstrates that for Smith these facts were not ends in themselves but were instrumentalized toward the defense of math education.

Institutional and Communal Struggles

While the history of mathematics community was always small, it had grown large enough by the late 1920s that its members began trying to set up the types of institutions that had held the math research and math education communities together since the 1890s. While historical articles had appeared in the *AMM* and *Mathematics Teacher* for years, an American journal dedicated to the history of mathematics had not yet materialized. The historians faced two obstacles to creating such a journal: first, money was always in short supply and the existing organizations were hesitant to fund a new periodical, especially after the beginning of the Great Depression; and second, historians struggled to generate interest in a new journal or get subscriptions, given how niche the field of history of mathematics was. While their first attempt, an effort at starting a journal called *Bibliotheca Mathematica*, never materialized, in 1932 they launched *Scripta Mathematica* and gave a home to American research in the history of mathematics. These years from 1927 to 1932 are useful to study as the period when the

[56] Letter from Miller to Smith, Dec. 22, 1923, *DES Professional Papers* box 34.

educational focus of historians of mathematics was formally encoded in the community's institutions. This decision did not go uncontested: the vision of history as a popularizing, educational agent had to overcome a competing vision that saw the enterprise as exclusively scholarly and cut off from pedagogical concerns.

The American most interested in starting an academic journal on the history of mathematics was R. C. Archibald. There are examples of such journals published in Europe since the nineteenth century, such as *Bibliotheca Mathematica*, edited by Gustav Eneström of Stockholm. Eneström was forced to end the publication after WWI began, but continued corresponding with Smith about the possibility of reviving *Bibliotheca*, perhaps in the United States.[57] Beginning in 1927, a few years after Eneström's death, Archibald led the effort to restart the journal, hoping to have it sponsored by the MAA.[58] While Archibald was optimistic about getting the project started quickly, by the summer of 1929 it had stalled; the MAA lacked the money to support the new journal, so the historians turned to other sources such as the AMS or National Academy of Sciences.[59] Increasingly desperate for any funding, Smith finally turned to his wealthy friend Plimpton, asking him in the course of a two and a half hour conversation for $30,000 to support *Bibliotheca*.[60] By the end of 1930, with the country's economy falling apart, Smith and Archibald seemed resigned that the journal would not reappear any time soon.

Alongside these financial challenges were other problems that hindered *Bibliotheca Mathematica* and made other mathematicians unwilling to back it. Archibald was the most enthusiastic historian pushing for the journal's refounding and would likely have served as editor-in-chief, but others were worried that his well-known combativeness would make him a

[57] Letter from Eneström to Smith, Oct. 10, 1915, *DES Professional Papers* box 15.
[58] The first communication relating to the *BM* revival I can find is a letter from Archibald to Smith, Oct. 22, 1927, *DES Professional Papers* box 2.
[59] Letters from Archibald to Smith, Aug. 17 and 21, 1929, *DES Professional Papers* box 2.
[60] Letter from Smith to Archibald, Aug. 15, 1930, *DES Professional Papers* box 2.

bad leader. Herbert Slaught, who had been involved in the MAA since its founding and was an intermediary between the organization and the historians planning *Bibliotheca*, expressed these concerns in his letters to Smith. He claimed that there were unnamed mathematicians within the MAA's leadership who had become "irritated by certain of Archibald's dealings almost to the point of declaring that they never wanted to get into contact with him again" and did not want him to dominate a project they were funding.[61] Slaught was not the only one to call attention to Archibald's temperamentality and lack of patience: Vera Sanford, while proofreading an article by Archibald, told Smith simply that "I'm scared of Professor Archibald, and worried lest he think me an unconscionable upstart."[62]

While this was merely an issue of Archibald's personality, Slaught also revealed a deeper structural problem for *Bibliotheca*: in 1929, he told Smith that the research mathematician Oswald Veblen, then serving on a National Academy committee distributing funds, did not consider historical research as important as the "scientific publications" featuring math research and would only approve funding for *Bibliotheca* after more important projects were supported.[63] Throughout the early twentieth century, the communities focused on research, education, and history had cooperated smoothly, as their members tended to overlap and their goals were broadly the same: getting more students interested in mathematics benefitted all three groups. However, when money was scarce the fault lines between the three communities became more pronounced. It should come as no surprise that the historians of mathematics, only just emerging as a distinct community, had their interests overridden by the more established and widespread research mathematicians.

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[61] Letter from Slaught to Smith, Dec. 3, 1928, *DES Professional Papers* box 46. Slaught felt such a need for privacy in voicing these concerns that he wrote the letter by hand rather than dictate it to a stenographer.

[62] Letter from Sanford to Smith, Mar. 18, 1928, *DES Professional Papers* box 42. Sanford was scared to confront Archibald on the issue of whether Abraham de Moivre's name should be spelled with a capital letter D.

[63] Letter from Slaught to Smith, Aug. 26, 1929, *DES Professional Papers* box 46.

It was not Archibald but Jekuthiel Ginsburg who was at the center of *Scripta Mathematica*, the journal that succeeded where *Bibliotheca* failed. In early 1932, Yeshiva's department of mathematics began publication of a quarterly journal, with Ginsburg (by then chair of the department) as editor-in-chief.[64] *Scripta* reflected Ginsburg's research interests and desire to attract new students to mathematics, combining the ideas in his youthful proposal to Yalden in 1916 with his years of experience working with Smith. As he explained in the opening to the first issue, *Scripta* was "primarily designed to serve as a means of communication between scholars engaged in the study of mathematics," satisfying the older historians' desire for rigorous scholarship and high standards.[65] However, this introduction to the publication also made clear that it was aimed at a general audience of non-experts and would remain "free from such technicalities as would repel the intelligent reader who has not had a thorough training in mathematics."[66] *Scripta*, intended to serve as a hub for the emerging historical community, also continued the practice of education and popularization followed by Smith throughout the 1920s.

This contrasted with goals Smith and Archibald discussed in their plans to revive *Bibliotheca*: while they did not exactly plan for the journal to be inaccessible to novices, Archibald made clear many times that he expected high research standards above all else. He intended for the journal to adopt *Bibliotheca*'s original editorial style under Eneström, which valued the "purely professional exposition" of mathematics' history above the less-rigorous "cultural history" of the subject.[67] Archibald felt that a scholarly domestic journal would be "a fine thing for the country," complaining that most writing on the history of math was being

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[64] As discussed above, the main reason earlier publications failed was a lack of money. I find no indication of where Yeshiva found the money to start a new journal.
[65] "The Policy of Scripta Mathematica," *Scripta Mathematica* 1 (1932): 1.
[66] "Policy of Scripta," 2.
[67] Kirsti Andersen, "Scandinavia," in *Writing the History of Mathematics: Its Historical Development*, ed. Joseph W. Dauben and Christoph J. Scriba (Basel: Birkhäuser Verlag, 2002), 154-155.

produced in other countries.[68] Smith and Archibald both conceived of history in strategic terms, but were oriented toward different goals: Smith was most conscious of the threat progressive educators posed to math education and saw history as a means of delegitimizing their critiques; Archibald's concern, largely separate from educational issues, was a desire to shift the academic world's center of gravity from Europe to America. It seems that Archibald was alone in this concern, as most of his fellow historians emerged from math education and felt the pressing need for popularization.

These two conceptions of how to present the history of mathematics played out in the conflict between Ginsburg and Archibald during the journal's early years. Smith invited Archibald onto *Scripta*'s board of editors early in 1932, stressing that "will not in any way take the place of Bibliotheca Mathematica, if, and when, the money is found to revive that journal."[69] Archibald agreed, happy to go along with what appeared to be a side project until *Bibliotheca* began.[70] However, as time went on, the impatient personality that had worried Slaught began to assert itself. In 1933, he scolded Ginsburg for bringing on so many associate editors, claiming that this would cheapen the journal's level of scholarship.[71] He complained privately to Smith many times in the following years, criticizing Ginsburg's inability to keep a schedule, his poor editing, and the difficulty of getting a clear answer from him when questioned.[72] Archibald never indicated a particular interest in *Scripta*'s goal of reaching a broad audience or introducing more people to mathematics; for him, its lack of editorial standards made it a subpar journal. Archibald finally left the project in 1937, telling Ginsburg that he would resign his position unless *Scripta*

[68] Letter from Archibald to Smith, Dec. 24, 1929, *DES Professional Papers* box 2.
[69] Letter from Smith to Archibald, Jan. 21, 1932, *DES Professional Papers* box 2.
[70] Letter from Archibald to Smith, Jan. 22, 1932, *DES Professional Papers* box 2.
[71] Letter from Archibald to Ginsburg, Jul. 4, 1933, *DES Professional Papers* box 2.
[72] Letters of Nov. 9, 1933, Nov. 1 and 10, 1934, and Nov. 10, 1935, *DES Professional Papers* box 2.

kept strictly to its quarterly schedule and Ginsburg gave up his editing duties (both demands that he recognized as impossible).[73] Certainly, the friction between these two historians was a result of their incompatible personalities, but it is important to recognize the deeper structural forces motivating them: Ginsburg and Archibald had two irreconcilable ideas of the historical research community's future identity. Ultimately, Ginsburg had Yeshiva's money on his side, and his (and Smith's) vision of popularization won out.

Popularization in the 1930s

Scripta Mathematica was the longest-lasting and most stable institution aimed at popularizing mathematics in early-twentieth century America.[74] It is significant not only for revealing the growing number of historians of mathematics, but also for its particular editorial focus that structured the community. This vision was, at its core, Smith's defense of mathematics education based on its cultural and historical value. While Ginsburg contributed his ideas about what a popular magazine on mathematics should look like, it was Smith and his extensive contacts across the mathematics and math teaching communities that made *Scripta* possible. All his professional interactions over the previous four decades—involvement in the various professional societies, organizing teachers into the International Commission on the Teaching of Mathematics, mentoring young educators at Teachers College—allowed him to mobilize those mathematicians who shared his concern with the human value of mathematics and invite them into the *Scripta* project. From the perspective of community-building, *Scripta* was Smith's creation.

[73] Letter from Archibald to Smith, Mar. 20, 1937, *DES Professional Papers* box 2.
[74] The journal continued its run until 1973, but its editorial style changed significantly after Ginsburg's death in 1957. This will be discussed further in the conclusion.

With few exceptions, the people most closely involved in the journal's publication were longtime friends of Smith. Archibald, Karpinski, and Simons all accepted invitations to serve as associate editors, as well as Cassius Jackson Keyser of Columbia's math department, Smith's former student Vera Sanford, and the European historians Thomas Little Heath and Gino Loria. Only two associate editors, Adolf Fraenkel of the Hebrew University in Jerusalem and Joseph J. Schwartz of Long Island University, were Ginsburg's rather than Smith's associates.[75] The authors who contributed articles to *Scripta* were a more varied group, but Smith's personal acquaintances still had a large presence. While Archibald had envisioned *Bibliotheca* as a national project to exhibit the strength of American research, *Scripta* was in many ways an international journal, supported by the international connections Smith made over his career. Ganguli, Mikami, and Loria contributed articles dealing with the mathematical histories of their respective countries.[76] Other acquaintances native to the U. S. wrote about various regions of the world, rounding out the journal's international presence: particularly unusual was Leslie Leland Locke of Columbia, who researched the history of Peruvian mathematics after studying under Smith.[77] Smith thus served as a sort of gatekeeper for contributions to the journal, promoting those authors who supported his project of defending math education.

The cosmopolitanism evident in this description of the community's writings of the 1930s can be understood as another strategy to justify math's cultural importance, this time in response to contemporary politics. With fascism and isolationism on the rise in Europe, the

[75] I find very little information about either of these editors. Neither of them have letters preserved in Smith's papers.
[76] Sarada Kanta Ganguli, "On the Indian Discovery of the Irrational," *Scripta Mathematica* 1 (1932): 135-141; Yoshio Mikami, "Mamoru Mimori," *Scripta Mathematica* 1 (1933): 254-255; Gino Loria, "J. Liouville and His Work," *Scripta Mathematica* 4 (1936): 147-155.
[77] Leslie Leland Locke, "The Ancient Peruvian Abacus," *Scripta Mathematica* 1 (1932): 37-43. Latin America was generally neglected among historians of mathematics. I found no evidence of communication between Smith and any South American historians or any research on the region other than Locke's.

humanistic community worked to present mathematics as a world-civilizational project that crossed borders and cultures. In 1937, with *Scripta* well-established, Smith contributed an article on the global nature of math for a volume on promoting understanding in the curriculum.[78] He first noted that "every important country of the world" (a list that included India, Egypt, Greece, England, and the Jewish nation) had made some contribution to mathematics, making a true product of world culture.[79] Through *Scripta*, Smith massed up evidence that reinforced this point. Turning to the political situation, Smith noted that the present time was defined by insecurity and fear, emotions that were directed against foreign nations. Math, which "leads to a saner reasoning and to a nobler outlook than most of our current literature provides," stood against this by turning people's' minds away from passing fears encouraged by demagogues to a knowledge of eternal truths and higher aesthetic values.[80] Given the curricular focus of this volume of essays, Smith's argument can be seen as a continuation of earlier discussions of math's cultural significance: his implicit claim was that math should be a required subject because it taught students to reject ultranationalism and militarism.

While history dominated the content of *Scripta*, other topics contributed to the popularization of math in various ways. Most of the journal's philosophical content was written by Cassius Jackson Keyser, a mathematician at Columbia who had been friendly with Smith since the beginning of the century. Keyser had produced a body of writing over the previous three decades articulating a humanistic understanding of mathematics' value as opposed to the

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[78] David Eugene Smith, "Mathematics: Its General Character," in *International Understanding Through the Public-School Curriculum,* ed. I. L. Kandel and Guy Montrose Whipple (Bloomington: Public School Publishing Company, 1937), 71-78. Smith's old colleague William Betz also contributed an essay for this collection explaining the need to require mathematics in high school.

[79] Smith, "Mathematics: Its General Character," 75.

[80] Smith, "Mathematics: Its General Character," 77.

utilitarianism or pragmatism advocated by progressives.[81] He saw rigorous thinking, as represented by abstract mathematics, as humanity's greatest defining trait and opposed the "current fallacy [...] of regarding what is called successful action as the touchstone of rigorous thinking."[82] This faith in mathematics for its own sake was shared by many contemporary research mathematicians, such as, for example, W. F. Osgood; what set Keyser apart and brought him into close affinity with Smith were his efforts to make abstract mathematics more accessible to laypeople. Like Smith, he was concerned with the connections between mathematics and other areas of culture, which he called the "bearings" of mathematics: "a certain rich manifold of light-giving relations that connect mathematics with those great human interests and human concerns."[83] He was not writing history, but his talk of relations and connections were a continuation of Smith's strategy within education to recenter America's conception of mathematics along cultural rather than vocational lines. *Scripta* gave Keyser a platform with which to propagandize math's importance as often as he wished.[84]

The remainder of *Scripta*'s content was a mixture of topics intended as accessible points of entry into mathematics from other areas of culture. For example, contributors frequently discussed aesthetics and the role geometry can play in understanding art and sculpture. Julian Bowes, a sculptor based in New York, contributed two articles on "dynamic symmetry," explaining the important role that proportion and symmetry played in classical works of art (and condemning modern art as "chaotic and retrogressive").[85] The same issue included a short poem

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[81] Recall from chapter 2 that Keyser condemned Snedden's approach to math education in 1916.

[82] Cassius J. Keyser, "The Human Worth of Rigorous Thinking," *Science* 38 (1913): 790.

[83] Cassius J. Keyser, "The Humanity of Mathematics," *American Scholar* 2 (1933): 155-156.

[84] Examples of articles by Keyser: "Mathematics as a Culture Clue," *Scripta Mathematica* 1 (1933): 185-203; "Mathematics and the Question of Cosmic Mind," *Scripta Mathematica* 2 (1933): 125-128; "Mathematics and the Dance of Life," *Scripta Mathematica* 3 (1935): 120-130.

[85] Julian Bowes, "Dynamic Symmetry," *Scripta Mathematica* 1 (1933): 236-244, 309-314. A footnote identified Bowes as "director of the school of Dynamic Symmetry," but I can find no record of this institution's existence.

by Mary Willard Gleason White connecting the divine order of the universe to the mathematician who "can compute the farthest decimal."[86] One of the more unusual contributors to *Scripta* was Royal Vale Heath, a New York magician who Ginsburg introduced to Smith. Heath was an expert on number games, arithmetic puzzles, and especially magic squares, a genre he named "mathemagic."[87] Ginsburg had envisioned such games as part of his student-focused math journal proposed in 1916, so it is unsurprising that he took advantage of Heath's magic squares for *Scripta*.[88] For Smith, these magic squares were not simply a fun distraction, but served as a point of reentry back into the history of mathematics: in 1936, Heath became interested in a magic square carved into gate of the Gwalior Fort, constructed in India in the 8th century.[89] Smith in turn reached out to his Indian peer A. N. Singh, requesting a photograph of the site, a translation of the Sanskrit engravings around the square, and any other information he could provide.[90] While Archibald placed a high value on academic research over these recreational "distractions," Smith saw no clean distinction between popularization and "serious" historical work: the many connections between mathematics and culture allowed readers to move back and forth between different sites of mathematical interest and develop a passion for the subject from any direction.

Adjacent to *Scripta* was a new means of propagandizing mathematics in the 1930s using modern communication technologies. In particular, historians of mathematics capitalized on educational radio broadcasts to reach a broader audience. While the exact content of these

[86] Mary Willard Gleason White, "Art Mindful of Him," *Scripta Mathematica* 1 (1933): 228. The website www.findagrave.com suggests that she was the wife of Henry Seely White, a mathematician at Vassar College who was involved with the AMS. The site provides no citation.

[87] Heath was fond of closing his letters to Smith with "mathemagically yours." *DES Professional Papers* box 23.

[88] Royal V. Heath, "A Curious Magic Square," *Scripta Mathematica* 3 (1935): 250; "Concentric Magic Squares," *Scripta Mathematica* 4 (1936): 66-67; "A Panelled Magic Square," *Scripta Mathematica* 4 (1936): 155.

[89] Letter from Heath to Smith, Mar. 7, 1936, *DES Professional Papers* box 23. This fort is well-known as the first recording of zero in mathematical notation.

[90] Letter from Smith to Singh, Mar. 26, 1936, *DES Professional Papers* box 45.

broadcasts is inaccessible today, it is still possible to get a general idea of their function in the broader context of popularization. Keyser's use of radio is unsurprising, given the broad audience of his books and articles over the previous decades. He delivered an educational broadcast on "The Story of Mathematics" in April 1935 over the station WNYC.[91] Smith responded positively, congratulating Keyser for his work and thanking him for the publicity on behalf of *Scripta*.[92] Raymond Weeks, a close friend, indicates that Keyser and his wife delivered another radio broadcast together early in 1940.[93] Karpinski's use of radio was noteworthy, according to a thesis advisee who described him as "an expositor and transmitter of new historical developments."[94] Karpinski also made use of the new technology of slide projection, designing a series of slides depicting images from the history of mathematics for use at the 1932 Chicago World's Fair.[95] Karpinski's and Keyser's goal—shoring up America's interest in mathematics in order to protect math education—remained the same, but they discovered new strategies for pursuing it as the technological landscape changed.

Over the two decades extending roughly from 1915 to 1935, Smith succeeded in transforming his personal project of defending math's cultural value into a fledgling academic discipline with growing membership and young institutions. The message consistent through his and his colleagues' writings was a high valuation of math's place in history, philosophy, art, poetry, and daily life in contexts meant to be accessible to non-specialists. What changed was the form this message took, moving from the occasional article in *Mathematics Teacher* or the *AMM* to a dedicated journal and an ever-growing collection of monographs. Original historical

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[91] Letter from Robert Newell to Keyser, n.d., *Cassius Jackson Keyser (CJK) Papers* box 2. This letter explains some of the logistic details of Keyser's broadcast and was likely written less than a month beforehand.
[92] Letter from Smith to Keyser, Apr. 12, 1935, *CJK Papers* box 2.
[93] Letter from Weeks to Keyser, Feb. 9, 1940, *CJK Papers* box 2.
[94] Phillip S. Jones, "Louis Charles Karpinski, Historian of Mathematics and Cartography," *Historia Mathematica* 3 (1976): 190.
[95] Jones, "Karpinski, Historian of Mathematics," 190.

research had a central place, but the editors of *Scripta* instrumentalized their research toward explicitly educational purposes, advancing an image of mathematics as cosmopolitan, aesthetically pleasing, and central to the human experience. While the NCMR report discussed in the last chapter attempted to meet the progressive attack on its own terms through means internal to the school curriculum, Smith's conception of humanistic mathematics attempted to recenter the conversation altogether, challenging progressives' notions of what mathematics is and what its purpose in the school could be.

The Successes and Failures of *Scripta Mathematica*

With *Scripta Mathematica*, Smith and Ginsburg hoped to get more students interested in mathematics by promoting a broader conception of the subject's cultural value. In this sense, the journal was a failure. When *Scripta* began, roughly a third of American students took algebra at some point, down from just over half at the beginning of the century. This number held steady or declined over the next 15 years, despite Smith and his colleagues' pleas on the importance of requiring high school math.[96] In other respects, *Scripta* was moderately successful: it generated excitement for the history and philosophy of mathematics among older American readers and provided an institutional center for the history of mathematics as a discipline. These successes should not distract from the stagnation of math education, but they deserve discussion as signs that Smith's project of public engagement paid off.

Most early reactions to *Scripta* were praise. Bernard Revel, president of Yeshiva, claimed that the journal's first issue received an enthusiastic response from scientists and academics that encouraged him to continue supporting the work "despite the difficulties encountered in the

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[96] See discussion on page 61.

realization of the project in these hard times."[97] The journal secured articles from a number of well-known mathematicians and scientists: Max Talmey wrote about his experiences tutoring Albert Einstein in his youth, the future Nobel laureate in physics Percy Williams Bridgman contributed an article on modern set theory from a physicist's perspective, and the theoretical physicist Hermann Weyl wrote an obituary for Emmy Noether, one of the era's most famous woman mathematicians.[98] Also impressive were the public figures who subscribed to the journal, including Supreme Court Justice Benjamin Cardozo, New York Governor Herbert Lehman, and president of the Irish Free State Eamon de Valera.[99] While the journal did not change the minds of students or school administrators, it clearly struck a chord among scientists and intellectuals. *Scripta* and the body of humanistic writing surrounding it also seemed to strike a chord with non-specialists. On many occasions, readers of Keyser's works wrote him letters thanking him for reintroducing mathematics into their lives.[100] Louis Rosen, a dancer living in the Bronx, read Keyser's 1929 essay "The Pastures of Wonder" and was inspired to write the author that "somehow definitely, I connect my love for the dance with a desire to delve into mathematical thinking"—a theme that would not be out of place in a *Scripta* article.[101] Margaret Davis, a teacher in Pennsylvania, decided to take math classes in her spare time and assign one of Keyser's books to her ninth graders after reading "Pastures."[102] And Sue Doherty, a student at

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[97] Bernard Revel, "Announcement," *Scripta Mathematica* 1 (1932): 93.

[98] Max Talmey, "Personal Recollections of Einstein's Boyhood and Youth," *Scripta Mathematica* 1 (1932): 68-71; P. W. Bridgman, "A Physicist Rediscovers Mengenlehre," *Scripta Mathematica* 2 (1933): 101-116; Hermann Weyl, "Emmy Noether," *Scripta Mathematica* 3 (1935): 201-220.

[99] "Address Delivered by Professor Keyser at the *Scripta Mathematica* Banquet," Mar. 1, 1936, *CJK Papers* box 7. I find no public record that these three actually subscribed to the journal, but I see no reason to doubt Keyser's statement in this address.

[100] I will discuss Keyser here both because he was probably the most widely-read of *Scripta*'s editors and because I had access to his papers. It is possible that Karpinski, Ginsburg, and Simons also received letters from fans that have since been lost.

[101] Letter from Rosen to Keyser, Aug. 4, 1935, *CJK Papers* box 2.

[102] Letter from Davis to Keyser, Sep. 3, 1935, *CJK Papers* box 2.

Wellesley College, claimed that the *Scripta* article "Mathematics and the Dance of Life" gave her "a conception of the power and beauty of pure mathematics, and a strong inspiration to go further in exploring it."[103] When discussing the attack on mathematics by progressive educators years earlier, E. H. Moore had told Smith that they needed good "propagandists for mathematics"; the group of humanistic writers with Smith and *Scripta* at its center provided just that.

[103] Letter from Doherty to Keyser, Oct. 10, 1946, *CJK Papers* box 4.

Conclusion

The story told in this thesis, extending through the 1930s, is one of the steady growth and consolidation of the history of mathematics community. Going further forward in time, however, it becomes harder to identify continuities. Within a few years of *Scripta Mathematica*'s founding, the volume of writing on the history of mathematics and the number of new authors entering the field were dropping.[1] *Scripta* issues of the first few years typically ran 50 to 80 pages of original articles, excluding book reviews and notes; one issue in 1936 reached a low of two articles totaling a mere six pages.[2] The problem of producing enough material to keep the journal going was compounded by the retirements and deaths of the original historians of math over the following years. David Eugene Smith died in 1944; Lao Simons in 1949; George Abram Miller in 1951; Raymond Clare Archibald in 1955; Louis Karpinski in 1956; and Jekuthiel Ginsburg in 1957. Their retirements were staggered (Sanford kept writing though the 1950s and Ginsburg edited *Scripta* until his death), but speaking generally there is a stark contrast between an active prewar period and a stagnant postwar.

To explain this decline, it is useful to compare Smith's establishment of the history of mathematics with George Sarton's pioneering of the history of science around the same time. Sarton was a Belgian chemist who became interested in the history of science in the early 1910s. He founded *Isis*, a journal dedicated to the history of science, in 1912 and actively promoted it to public intellectuals such as Henri Poincaré, Émile Durkheim, Henri Bergson, and David Eugene

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[1] Uta C. Merzbach, "The Study of the History of Mathematics in America," in *A Century of Mathematics in America, Part III*, ed. Peter Duren (Providence: American Mathematical Society, 1989), 653.
[2] *Scripta Mathematica* 4 (1936): 301-306.

Smith.[3] Smith, 24 years older than Sarton, responded positively to the project and gave the young historian of science help throughout his early career: he advertised *Isis* to his American colleagues; he helped Sarton find an academic position in the U. S. when he was forced to leave Belgium after the German invasion of 1914; and in 1924 he played the leading role in founding the History of Science Society, organized to support the publication of *Isis*.[4] An observer in the mid-1920s would likely have seen the history of math as the more promising field and Smith as a more influential historian than Sarton.

This did not turn out to be the case in the long run. Smith and Sarton embodied two trajectories of discipline-formation: Smith's history of math grew quickly but then declined after his death, whereas Sarton's history of science took several decades of fallowness before flourishing from the 1950s up to the present. Smith's approach, as discussed in chapters two and three, was informed by the crisis in math education and was designed to convince educators of math's importance as quickly as possible. He relied on his charm and influence, personally bringing young mathematicians into the field and building up a close community around himself. Sarton's approach was more impersonal, taking on few Ph.D. candidates and sticking to small undergraduate classes during his career at Harvard.[5] He focused almost exclusively on the task of writing itself, leaving behind the tools and sources that later historians of science could make use of without knowing Sarton personally. A good example is the critical bibliographies that Sarton compiled for *Isis,* in which he listed and briefly analyzed tens of thousands of publications related to the history of science over the course of his career. Sarton was explicit in his goal for this project, writing that "the aim of this bibliography is to establish the History of Science as an

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[3] "Sarton, George Alfred Léon," in *Complete Dictionary of Scientific Biography*, vol. 12 (New York: Charles Scribner's Sons, 2008), 108. Letter from Bergson to Sarton, Apr. 12, 1912, *Sarton Additional Papers* folder 108.
[4] Letter from Smith to Sarton, Oct. 25, 1912, *Sarton Additional Papers* folder 1466. Letter from Sarton to Smith, Apr. 10, 1915, *David Eugene Smith (DES) Professional Papers* box 43. "Preface to Volume VI," *Isis* 6 (1924): 4-5.
[5] *Dictionary of Scientific Biography*, 112.

independent discipline and to serve as a center of information and a rallying ground to the scholars engaged in these studies."[6] Sarton's approach was not simply to contribute to the history of science, but also to organize the discipline in such a way that future historians could build on his work.

Looking back at Smith's career, it is difficult to identify a particular way of "doing" the history of math that he elaborated through his extensive writings. The introductions to his books tend not to share Sarton's concern for methodology or identity-formation. In the preface to his *History of Mathematics*, which one might expect to be a field-defining work based only on its title, Smith simply reiterated his educational focus, noting his hope that it be used as a textbook in history of math classes.[7] One cannot learn the details of how the history of math is written by reading Smith's books; presumably he communicated this knowledge to his disciples in person. The closest Smith came to Sarton's critical bibliography project was *Rara Arithmetica*, his catalogue of the texts in George Arthur Plimpton's library; uncoincidentally, this is one of Smith's most well-regarded texts, typically receiving special praise in later retrospectives on his work.[8] Smith came close to this bibliographic genre a second time with the *Source Book in Mathematics* of 1929, which collected short translations of major mathematical works; while this bore a superficial similarity to the critical bibliographies, Smith made clear in the preface that his intended audience consisted of teachers and students rather than historical researchers.[9] Based solely on his published writings, it is difficult to guess what Smith wanted the future of the

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[6] George Sarton, "Twelfth Critical Bibliography of the History and Philosophy of Science and of the History of Civilization (to March 1922)," *Isis* 4 (1922): 573.
[7] David Eugene Smith, *History of Mathematics*, vol. 1 (New York: Dover, 1923), iii.
[8] For example: Merzbach, "History of Mathematics in America," 645-646; "Notes and Correspondences," *Isis* 35 (1944): 213.
[9] David Eugene Smith, *A Source Book in Mathematics* (New York: McGraw-Hill, 1929), ix.

history of math to look like; he was instead preoccupied with the immediate needs of math education.

This focus on popularization at the expense of an explicit methodology worked against the history of math. While Smith and his contemporaries remain well-regarded today, the few writers who immediately followed them do not. This trend away from respectable scholarship is exemplified in Eric Temple Bell, who was famous from the 1930s through the 1950s for his historical works popularizing math. Despite his popularity, Bell was recognized as less than a meticulous historian. G. Waldo Dunnington noted that "the circumspect, careful reader will find a considerable number of examples of such 'exaggeration'" in Bell's work, while Alonzo Church criticized "a number of serious errors of detail" evident in Bell's narration.[10] Those who speak fondly of Bell today seem almost embarrassed to do so: Roberts, describing the inspiration he took from Bell's *Men of Mathematics*, admitted that the work "has in recent years been the subject of sharp criticism, to which I offer no defense, but the inspiration of the book remains."[11] The conflicts between Smith and Miller in the 1920s and Ginsburg and Archibald in the 1930s saw the ascendance of popular history over purely scholarly history, but in the hands of less-skilled historians this deteriorated into sensationalistic writing.

This lack of methodological identity mirrored a lack of firm institutional identity. Sarton worked hard to establish institutions that are still central to the history of science today, notably *Isis* and the History of Science Society. While Sarton began his time at Harvard as a lecturer in the philosophy department, he eventually secured tenure as a professor of the history of science,

[10] G. Waldo Dunnington, review of *Men of Mathematics* by E. T. Bell, *National Mathematics Magazine* 11 (1937): 406; Alonzo Church, review of *The Development of Mathematics* by E. T. Bell, *Journal of Symbolic Logic* 5 (1940): 152.
[11] David Lindsay Roberts, "Mathematics and Pedagogy: Professional Mathematicians and American Educational Reform, 1893-1923" (PhD diss., Johns Hopkins University, 1997), vii.

an important step in legitimizing his field.[12] The historians of math were not as successful at securing permanent institutions, so their research project was more transient. The lack of a History of Mathematics Society is especially surprising given Smith's major role in founding the History of Science Society; for whatever reason, he never founded a society specifically dedicated to the history of math. Within the universities, the historians of math were typically confined to schools of education or occasionally math departments. There were only a few examples of professorships in the history of math: Florian Cajori was made a professor of the history of mathematics when he was appointed to the University of California in 1918, largely a ceremonial gesture for a scholar reaching the end of his career.[13] The only other example from this period is Otto Neugebauer, who established himself as a leading German historian of math in the 1920s before fleeing Europe for the U. S. in 1939 and establishing himself as professor of the history of mathematics at Brown.[14] In other words, the only example of a history of math department emerged outside the context of America's math education community. Even *Scripta Mathematica*, the only institution produced by the community, proved fragile. After Ginsburg's death in 1957, Abe Gelbart took over his job as editor-in-chief. Without explanation, Gelbart changed the journal's subheading from "A Quarterly Journal Devoted to the Philosophy, History, and Expository Treatment of Mathematics" (which it had used since 1932) to "A Quarterly Journal Devoted to the Expository and Research Aspects of Mathematics," expunging the history of mathematics from the journal's identity.[15] Smith's strategy of assembling a few close associates in defense of mathematics turned out to be incompatible with long-term institutions:

[12] *Dictionary of Scientific Biography*, 110.
[13] Raymond Clare Archibald, "Florian Cajori, 1859-1930," *Isis* 17 (1932): 386. I know of no Ph.D. candidates Cajori accepted at California, which calls into question the importance of his specialized professorship there.
[14] Merzbach, "History of Mathematics in America," 660. Merzbach reports that as late as the 1960s, Neugebauer's was the only department of the history of mathematics in the country.
[15] *Scripta Mathematica* 23 (1957).

once the original historians died, those that replaced them had no compulsion to continue the historical research project.

This slow collapse lends an ambiguous tone to the end of the current narrative. If any broader claim about community-formation can be extrapolated from this thesis, it is that it is a highly context-specific process: the social organization of an intellectual community is drawn along the same lines as the social order from which it emerged, and the forms of knowledge that the community produces will align with the needs and goals of its parent community. Given Smith's context of educational crisis, one could leave this topic with the impression that the history of math was shackled to math education, that it had no hope of achieving long-lasting independence, and that all of Smith's efforts amounted to nothing. However, this view undervalues the radically creative nature of Smith's foray into the history of math. Interdisciplinary study is a trendy topic in higher education today, where there is a vague sense that the traditional academic disciplines are no longer adequate and that their boundaries must be challenged.[16] This struggle against artificial boundaries has in fact been present throughout this thesis, manifesting in Felix Klein's fixation on the unity of abstract mathematics, in E. H. Moore's efforts to bridge pure and applied math, and in Smith's claim that math is a throughline of world culture that clarifies the meaning of history, music, and poetry. If we actually value interdisciplinary knowledge as a defining feature of the modern liberal arts, then it is important to recognize that scholars such as Smith were doing the same almost a full century ago. In this sense, Smith's legacy was to reveal a space of creative possibility on the boundaries of existing institutions in which new forms of knowledge could be produced.

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[16] For example, the College of William & Mary's recent switch to its new College Curriculum was made with the justification of bringing the liberal arts into the modern age and includes a heavy focus on interdisciplinary classes. See http://www.wm.edu/as/undergraduate/curriculum/coll/index.php.

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