"The Bedrock of Logical Thought": Mathematics on the Television in 1957

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In September 1957, University of Michigan topologist Raymond Wilder received a letter from NBC producer Marilyn Kaemmerle. "This fall," she wrote, "the National Broadcasting Company in cooperation with the Educational Television and Radio Center [ETRC] in Ann Arbor will produce a group of educational television programs as a service to the educational television stations of the country … Our purpose is to encourage new interest among young people in the subjects being presented. One of these is mathematics … I hope you will want to participate in this pioneering experiment."

Hers was not a hard sell. Three months later, "The Bedrock of Logical Thought"—"starring" Wilder—had been filmed in New York City and had been shown as the seventh in a ten-part series entitled "Mathematics" on the just over two dozen stations affiliated with the ETRC [1, p. 105].

On a recent trip to the Archives of American Mathematics, a veritable treasure trove of insights into the history of mathematics in the United States that is part of the Briscoe Center at the University of Texas at Austin, I discovered the script of Wilder's otherwise ephemeral show [13].[1] This Years Ago column centers on that archival find at the same time that it fleshes out the context of mathematics on the television in the 1950s.

Behind the Scenes

Following the end of World War II, as television supplanted radio in households across the United States, educators at all levels found themselves with yet another new technological challenge. They had tried with limited success to adapt radio to their purposes—whether at the elementary or more advanced levels or for the adult audience—following World War I.[2] What were the possibilities for television in the aftermath of World War II as they still struggled to put radio to effective use? Should they persist in their efforts or try to move to the new medium?

The suggestion of at least a partial answer to this question came early in the 1950s. In March 1951, the Federal Communications Commission proposed that 209 noncommercial channels be provisionally reserved (out of 1,965) across the country and across the broadcast spectrum for educational television [1, p. 81]. A month later, the Ford Foundation, which in 1950 had explicitly taken as one of its philanthropic objectives the strengthening, improvement, and expansion of education, created a Fund for Adult Education (FAE) [1, pp. 83–84].[3] Specifically, the FAE aimed to increase "opportunities

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[1] While it is certainly the case that the recordings of some early television shows remain, thus far I have not succeeded in finding a recording of the series in which Wilder's program aired.

[2] On the use of the radio by mathematicians themselves, see [9].

[3] The quotation that follows is on p. 90. The Ford Foundation also established the Fund for the Advancement of Education, separate from but largely in conjunction with the FAE, in 1951.

https://doi.org/10.1007/s00283-024-10334-5

Figure 1. Marilyn Kaemmerle, from *Colonial Echo*, 1945, Special Collections Research Center, Swem Library, College of William and Mary.

for adult Americans to prepare themselves better to fulfill their responsibilities as citizens" [5, p. 3]. What ensued was "an informal but close relationship between the two organizations. The Federal Communications Commission needed the assurance that the reserved channels would be used; the FAE needed assurance that the reservations would be made firm" ([1], p. 90). To these ends, the FAE made grants of $100,000 to universities and $150,000 to metropolitan areas toward the purchase of equipment necessary to get educational stations up and running. Between 1953 and 1961, in fact, it had given upward of $4 million to thirty-three educational television stations across the nation [1, pp. 97–98].

In November 1952, moreover, an FAE grant funded the Educational Television and Radio Center in New York City, which by 1954 had moved to Ann Arbor, Michigan, and which served as "a clearinghouse for educational-television program material" [6, p. 17].[4] In other words, although it did not produce films itself, it "collect[ed] and distribute[d] completed films, exchange[d] kinescoped programs among educational stations, and contract[ed] for the production of new programs." In 1957 and 1958, it found a natural partner in the New York City-based National Broadcasting Company, the educational aims of which were "to *serve* by television, and *not* to replace the home, the school, the church, the university."[5]

Over that two-year period, the ETRC and NBC cosponsored—and Marilyn Kaemmerle (Figure 1) of NBC produced—fifteen different series [1, pp. 109, 244 (note 29)]. Kaemmerle had followed her 1945 graduation from the College of William and Mary, in Williamsburg, Virginia, with several positions in communications before landing her job at NBC. She had actually caused quite a stir at her alma mater when as editor of the student newspaper *Flat Hat*, she wrote an opinion piece entitled "Lincoln's Job Half Done …" that argued, among other things, for the desegregation of the college. Inflamed, the school's governing Board of Visitors urged that Kaemmerle be expelled, but when cooler heads prevailed, she was instead forced to resign from the editorship [2, p. 118]. It was thus a woman of strong, liberal principles and determination that NBC had taken on as a producer.

Kammerle and her teams began by putting together five series that aired in the spring of 1957—"The American Scene," "Geography for Decisions," "Mathematics," "American Government: Pursuit of Happiness," and "Highlights of Opera History"—treating social studies, the arts, and, interestingly, mathematics [1, p. 244 (note 29)]. The mathematics series, of which I have thus far been able to find no further traces, must have been popular enough to warrant a second series in the fall, namely, the one in which Wilder participated.[6] Yet mathematics would seem actually to have been an unlikely topic for a series, even on educational television, in the 1950s, given that "subjects that w[ould] be easiest to exploit visually, i.e., those that len[t] themselves readily to demonstration, movement, and the introduction of visual aids" were generally those that were selected for production and programming [3, p. 152].

Be that as it may, Kaemmerle and her staff for the mathematics series—Howard Fehr, professor of mathematics education at Columbia; William Welsh, NBC scriptwriter; and Clifton Fadiman, book and magazine editor as well as radio and television personality—had "been working with members of both the National Council of Teachers of Mathematics and the Mathematical Association of America to build a series which [would] highlight the intellectual excitement of [mathematics]."[7] By the time she wrote her letter of inquiry to Wilder, topics for the ten half-hour fall shows had been settled on: the discovery of number, Euclidean and non-Euclidean geometry, algebraic equations, coordinate geometry, probability and statistics, the development of the calculus, axiomatization of subjects, set theory, logic and computing, and mathematics in operations research. It was for the seventh of these, the "axiomatization of subjects," that Kaemmerle sought Wilder's involvement. When he agreed to be part of their experiment in educational television programming, she and her working group were "enormously pleased."[8]

By the end of October, Wilder, in Ann Arbor, and Welsh, in New York City, had been in touch by telephone

[4]The next quotation is also on this page.

[5]Reference [11, p. 42] as quoted in [8, p. 231] (my emphases). Here, the idea was that television would augment but not supplant other, more traditional, sources of education.

[6]The other shows in the fall of 1957 were "The International Geophysical Year," "Arts and the Gods," and "Survival." In the spring of 1958, only three series were produced: "Decision for Research," "Briefing Session," and "The Subject Is Jazz," while in the fall, the number was down to two: "Ten for Survival" and "Adventuring in the Hand Arts." See [1, pp. 244–245 (note 29)].

[7]Kaemmerle to Wilder, September 17, 1957, in [13].

[8]Kaemmerle to Wilder, September 30, 1957, in [13].

Figure 2. Raymond Wilder in 1955 (Wikimedia Commons).

to exchange ideas about the actual content that Welsh would then transform into the script of the show that Kaemmerle and the team had decided to call "The Bedrock of Logical Thought."[9] Wilder and Welsh's initial brainstorming had isolated three "breakthroughs" that could potentially serve both to structure and to add a certain amount of "drama" to the production: "Breakthrough: Number, algebra, arithmetic all had a system like geometry in which we proved things"; "Breakthrough: Office manager, engineer … social scientist … physicist … all attempting to do something in their fields, look for a set of things which they won't attempt to define"; "Breakthrough: Independent of elements in the system as long as the elements obey the system. Great universality of use."[10] With these ideas and various others to go on, it was then up to Welsh to generate an appropriate script for Wilder and Fadiman's show.

Dramatis Personae

As the mathematical "star," Wilder (Figure 2) was a natural choice in terms of both his mathematical expertise and his community-minded interests. While a graduate student under Robert L. Moore at the University of Texas at Austin, he had experienced firsthand Moore's axiomatic approach to mathematical research and had gone on to write his doctoral thesis in 1923 on what had been an open problem in point-set topology that Moore had posed to Wilder's class.

After accepting an assistant professorship at the Ohio State University in 1924, Wilder had established a reputation as one of the movers and shakers not only in topological research but also in American mathematics writ large from the position he took at the University of Michigan in 1926. Indeed, in 1957, when Kaemmerle contacted him, he had just finished a two-calendar-year stint as president of the American Mathematical Society. Perhaps even more important for NBC's purposes, the book *Introduction to the Foundations of Mathematics*, which he had published in 1952 based on the successful course he had developed at Michigan on precisely the topic of the proposed seventh episode, strongly testified to his abilities as a mathematical communicator [12].[11]

Wilder played opposite Clifton Fadiman (Figure 3), by then a noted voice on radio and a recognized television personality. From 1938 to 1948, for example, Fadiman had hosted the popular NBC radio quiz show "Information Please!," in which a panel of subject experts, together with a celebrity guest, humorously bantered as they tried to answer questions submitted by listeners. When CBS revived the radio show for television in the summer of 1952, viewers were *visually* treated to the show's intellectual sparring and found in Fadiman as engaging a host on television as he was on radio.

Fadiman's longest-running television show, however, was CBS's hour-long musical variety show "This is Show Business," which aired from 1949 to 1954 and was then revived by NBC in the summer of 1956. Described as "a wordsmith known for his encyclopedic knowledge," Fadiman, like Wilder, was also a natural for a series on mathematics [10, p. B8]. In 1957, he was actually at work on *Fantasia Mathematica*, an anthology, published by Simon & Schuster in 1958, that reprinted selected short stories, poems, and other mathematically themed literary works by such noted authors as Lewis Carroll, Martin Gardner, G. H. Hardy, Robert Heinlein, Aldous Huxley, Edgar Allan Poe, and H. G. Wells [4]. Fadiman's was certainly a "name" that had the potential to draw an audience even to a subject as seemingly daunting as mathematics.

The filming that ultimately took place at the NBC studios in New York was basic. As noted in the script, while Fadiman was on camera introducing the episode, Wilder was off camera, seated at a nearby table. At the end of his introduction, the script directed Fadiman to move to the table and sit opposite Wilder for the conversation to ensue. Props were few: cards printed with text that Wilder periodically held up as prompted, a *Century Dictionary* that Fadiman used to look up a word, a globe that Wilder walked over to consult. The show was further enhanced by so-called super rules, which were texts that occasionally appeared at the top of the television screen while Wilder and Fadiman were talking and that literally spelled out an axiom here, an equation there (Figure 4). All in all, this hardly made for compelling television viewing, even if it was admittedly more dynamic than, as would have been more usual, watching the back of a professor writing on and speaking to a blackboard in a lecture hall!

[9]Kaemmerle to Wilder, September 17, 1957, in [13].

[10]William Welsh to Raymond Wilder, October 29, 1957, in [13].

[11]For a laudatory review, see [7].

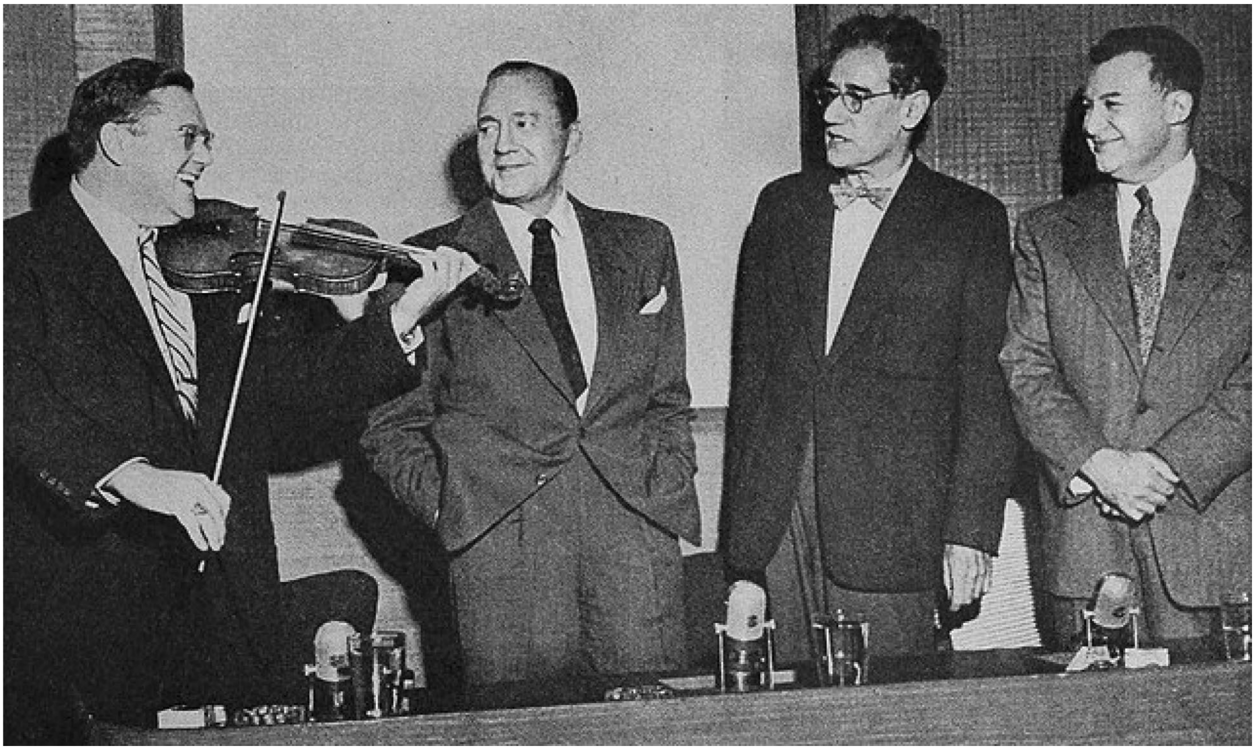


Figure 3. Clifton Fadiman (right) with, from left to right, Sam Levenson, Jack Benny, and George S. Kaufman (Wikimedia Commons).

The Plot

For Wilder and Fadiman's episode, then, the "drama" would be in the concepts that they would discuss. The half-hour show—which aired in the coveted time slot 6:00–6:30 pm (EST)—opened with Fadiman asking his television audience the rhetorical question, "How do you define mathematics?" [13, script, p. 2].[12] "If you should put that question to the man in the street," he continued immediately, "I am sure you would get a number of colorful and interesting answers, all of them guaranteed to be incomplete, inaccurate, or both. If you put the same question to a mathematician, you are almost guaranteed to get a simple answer—an almost hopeless shrug of the shoulders." As Fadiman went on to explain:

> The truth, of course, is that mathematics defies definition. One reason it does is that it obstinately refuses to "stay put." New mathematics is being created all the time and new applications are constantly being discovered for old mathematics. Our title: "THE BEDROCK OF LOGICAL THOUGHT" deals with one of the chief tools used in this constant creative process. We can call this tool the axiomatic method.

Fadiman, thanks undoubtedly to Wilder's input, had thus opened with a clear statement of mathematics' dynamic nature. It was not the seemingly ossified subject that students tended to encounter in schoolroom instruction.

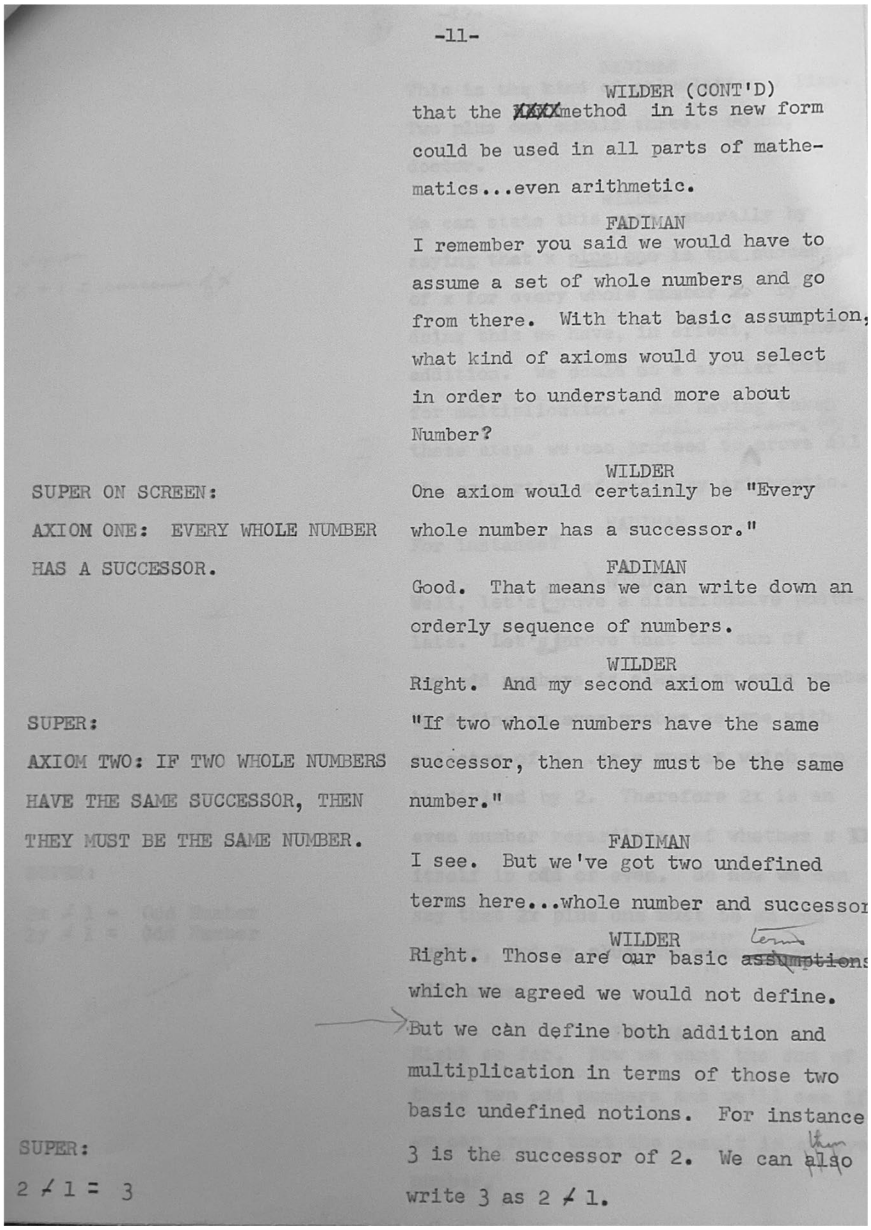
Enter Wilder, the expert, charged with illuminating the axiomatic method for his viewers. He began the story with Euclid and his *Elements*, explaining, first, that the ancient Greeks had made "the great discovery … that one could take a few assumptions for granted," "the so-called common notions," and "Then, by pure logic, they could derive from these assumptions the remainder of geometry" [13, script, p. 3].[13] "But," Fadiman interjected, "didn't they imagine that they were thus discovering the true facts about the space in which we live[?]" "That was their aim, but" Wilder qualified, "not their real achievement. What they actually did was give us a means by which one can—without even looking at the object studied—start with a few properties of the object and then deduce the rest of the properties by logic."

Bouncing this idea back and forth between them for a minute, Fadiman asked, "How long did it take us to wake up to the fact that we could use this same general system of axioms in other realms of human experience?" [13, script, p. 4].[14] "Not until the 17th century," Wilder replied, "did we make such attempts and that was largely because of the failure of other methods such as philosophizing … and also because of the prestige mathematics was beginning to enjoy

[12] This and the quotations that follow in this paragraph are also from this page in the script.

[13] The quotations that follow in this paragraph are also on this page.

[14] The next quotation is also on this page.



-11-

WILDER (CONT'D)
that the XXXX method in its new form could be used in all parts of mathematics...even arithmetic.

FADIMAN
I remember you said we would have to assume a set of whole numbers and go from there. With that basic assumption, what kind of axioms would you select in order to understand more about Number?

SUPER ON SCREEN:
AXIOM ONE: EVERY WHOLE NUMBER HAS A SUCCESSOR.

WILDER
One axiom would certainly be "Every whole number has a successor."

FADIMAN
Good. That means we can write down an orderly sequence of numbers.

SUPER:
AXIOM TWO: IF TWO WHOLE NUMBERS HAVE THE SAME SUCCESSOR, THEN THEY MUST BE THE SAME NUMBER.

WILDER
Right. And my second axiom would be "If two whole numbers have the same successor, then they must be the same number."

FADIMAN
I see. But we've got two undefined terms here...whole number and successor

WILDER
Right. Those are our basic ~~assumptions~~ terms which we agreed we would not define.
But we can define both addition and multiplication in terms of those two basic undefined notions. For instance 3 is the successor of 2. We can ~~also~~ then write 3 as 2 + 1.

SUPER:
2 + 1 = 3

Figure 4. Page 11 from the script of Wilder and Fadiman's show indicating the placement of three super rules. The editorial give and take is also evident here in the wording changes (Wilder Papers, Archives of American Mathematics, Dolph Briscoe Center for American History, The University of Texas at Austin).

because of its obvious success in such things as astronomy." A brief discussion of the failed attempts of Enlightenment philosopher Benedictus de Spinoza to lay out a philosophical system based on axioms and theorems followed, with Wilder noting that Spinoza's failure had hinged on an inability to settle on the precise definition of terms.

There Fadiman stopped him: "That would seem, on the face of it, like a fairly simple problem. If you want a definition, go to the dictionary" [13, script, p. 5].[15] "But it's not that simple," Wilder countered. Holding up a card that read "She is fair," he said, "Here is an uncomplicated example." When Fadiman instantly agreed that indeed, it was "a common enough sentence all right," Wilder dug into the problem. "But what does it mean precisely? We know what 'she' means and what 'is' means, but what are we trying to say when we use the word 'fair'?" This sent Fadiman to his prop, the *Century Dictionary*, from which he then read out a host of meanings of the word "fair." Wilder had proven his point, which allowed him to conclude that "to achieve a precise and unambiguous meaning, we must have a precise and unambiguous definition of each word we use. Once this was understood, we were ready for a

[15]For the quotations that follow in this paragraph, see pp. 5–7.

great advance in mathematical thought. This advance came with the introduction of non-Euclidean geometries."

That remark moved the discussion to some of the basics of axiomatic systems. Above Wilder's and Fadiman's heads on screen appeared a "super rule" that read [13, script, p. 8]:[16]

1. Consistency
2. Independence
3. Sufficiency.

To Fadiman's quip that it "sounds like a fraternity," Wilder good-naturedly agreed that "it might be a good motto for a mathematical fraternity at that." He then proceeded to explain both what each of these three terms means relative to the construction of an axiomatic system and that such systems can be formed in contexts, like the basic context of "number," very different from Euclidean geometry. "Doing something like that," Fadiman marveled, "must have represented quite a departure for the mathematician" [13, script, p. 10].[17] "Yes," Wilder acknowledged, "this was one of the real turning points in mathematics, this realization that the method in its new form could be used in all parts of mathematics … even arithmetic." Breakthrough number one: areas other than Euclidean geometry can be axiomatized.

With this, Wilder proceeded to lay out several axioms for whole numbers—"every whole number has a successor," "if two whole numbers have the same successor, then they must be the same number," etc.— which sequentially appeared as super rules at the top of the screen, as well as an example of a fact—"the sum of two odd numbers is always an even number"—that Wilder proceeded actually to prove from the axioms [13, script, pp. 11–12]. Although Fadiman found the latter "a very pretty demonstration," he next posed what one of his contemporaneous television show hosts might have termed the sixty-four thousand dollar question: "but what good does it do us? Why bother basing other parts of mathematics on axioms. Doesn't the whole thing degenerate into a mere game?" [13, script, p. 13].[18] "That's a very good question, Mr. Fadiman," Wilder granted, "and there are several good answers to it, all of them important."

First, Wilder explained, "It is important from the standpoint of the mathematician to be able to point to an axiom system and say, 'This is what I mean by Euclidean geometry' or Algebra … or the real number system, or whatever these particular axioms deal with … Your mathematician may not be able to define mathematics, but in this way he can define particular mathematical domains" [13, script, p. 14].

When Fadiman pressed for further clarification, Wilder led him, after introducing the notion of a model, to the conclusion that "the real beauty of a system of axioms lies in its economy. A set of theorems which we originally drew up with one kind of model in mind, can be taken and, with different interpretations, applied to another kind of model entirely … perhaps to something their originator never even heard of!" [13, script, p. 15].[19] "Yes," Fadiman marveled, "it's not hard to see why generality is such a sought after quality."

Second, Wilder went on, "many practical applications of mathematics have been made because of this quality" [13, script, p. 16]. Within mathematics, for example, "we've found that there is more than one kind of geometry—that there are non-[E]uclidean geometries as well as Euclidean geometry … [and] there is more than one kind of logic" [13, p. 18]. Moreover, one of the latter, symbolic logic, "has become quite important in the theory of computing and in its various ramifications. And we're beginning to discover that this relationship is by no means a one way street. Some investigators are now putting computing machines to work proving theorems" [13, script, p. 19].[20] Again, Fadiman was struck: "A machine proving a theorem? That sounds like it came from the pages of a science fiction magazine."

Yet, it was even more amazing than that. "Now that the axiomatic method has evolved into a rigorous procedure not restricted to geometry, or even to mathematics … the engineer, the machine designer, the social scientist, have all found it a useful way of approach to many of their problems" [13, script, p. 20]. Breakthroughs number two and three: the undefined terms in an axiom system can be interpreted in other contexts—as can the theorems proved—for great generality of use.

Still, after laying out all of these successes, it was important that viewers not be left thinking that there was no more work to be done. To Fadiman's question, "there must be some unsolved problems in the field, aren't there?" Wilder responded, "Oh yes," and while "many of them are too technical to go into here … one of the unsolved problems is the problem of consistency" [13, script, p. 21].[21] A very brief explanation of that problem led Fadiman to comment with tongue in cheek, "It makes you wonder. If we can't prove the consistency of the real number system, maybe I've got six fingers on this hand instead of five. Those machines had better hurry up with more proofs!"

With that, Fadiman rose, leaving Wilder at the table where they had been sitting, as the camera panned to follow him. Moving into his wrap-up, he thanked Wilder for "a fascinating and informative discussion," before closing with the hope that "we have been able to show that the very bedrock of all logical thought is this method of using a system of axioms—a minimum number of agreed upon, undefined terms to prove theorems within a system which will be consistent within themselves. The ramifications of this relatively simple logical process extend into nearly all fields of human endeavor, touching the lives of us all."

[16] The two quotations that follow are also on this page.

[17] For the quotation that follows, see pp. 10–11.

[18] For the next quotation in this paragraph, see p. 14.

[19] The quotation that follows is on p. 16.

[20] The quotation that follows is also on this page.

[21] For the quotation that follows, see p. 22.

Figure 5. A family watching television in 1958 (Wikimedia Commons).

The Reviews

That Wilder and Fadiman's show fundamentally connected with at least one viewer was evident in a letter to Wilder, apparently written immediately following the show.[22] Reflecting on Wilder's presentation, Andrew Smith, an adult viewer from Highland Park, Illinois, who was "interested in the Fine Arts and [who had] thought much about style," found interesting parallels between "what the creative writer, painter, musician, poet etc." do and "what the mathematician does in using certain basic undefined terms and making assumptions from them—with consistency, independence and sufficiency." As Smith saw it, "The modern artist is well aware that it is quite possible to do a work in the academic style, then the classical, non-objective or whatever his choice at will—examples in the work of Picasso, Stravinsky, Prokofieff—by the subtle changing in his brain of sets of assumptions and carrying them out in a consistent manner in a model." "This is very revealing to me," Smith confessed, "for as a student I was driven from mathematics by teachers whose whole method was a series of quizzes (surprise!) and tests on the 'practical' application of math with no lucid explanation of the basis of the method." Smith would appear to have been just the sort of adult viewer that the FAE and ERTC had been hoping to reach through their programming.

Reviews of the series as a whole also came in to NBC from all over the country at a rate that Kaemmerle described as "superb."[23] High school and college teachers of mathematics watched it; high school and college students watched it; men watched it; women watched it; families watched it together (Figure 5). People who had long liked mathematics watched it, as did some who had not. From Seattle, Washington,

[22]Andrew Smith to Raymond Wilder, December 9, 1957, in [13]. Given that the show aired on December 10, Smith must have mistakenly dated his letter. The quotations that follow in this paragraph are from his letter.

[23]Marilyn Kaemmerle to Raymond Wilder, February 1, 1958, in [13]. The quotations that follow are from the excerpts Kaemmerle sent to Wilder.

John Asseward wrote that "if some such method could have found its place in our high school experience … I am sure that many of us who struggled through … would have been inspired to greater efforts and inquisitiveness." E. L. Staples, of Butler, Pennsylvania, urged NBC to "continue your program," admitting that "as a layman without benefit of college, I find that I can understand your presentation." On behalf of his whole family, Fred A. Hanninger, of Omaha, Nebraska, wrote to say that "we just recently got an antenna for the sole purpose of receiving KUON-TV in Lincoln, 60 miles away. Let me take this opportunity to say it was well worth all the trouble and expense. We are enjoying all the programs but especially the Mathematics topics moderated by Clifton Fadiman. And from Auburn, Alabama, Edward Wegener, the director of educational television at the Alabama Polytechnic Institute, exclaimed, "Hurray for what you are doing for educational television! … it's a fascinating series … I find myself being extended mentally, imaginatively … even in the boon docks we know a good thing when we see it." As Kaemmerle put it to Wilder, "This is the real reward. … [the comments] make all the effort worthwhile."[24]

While it is hard to gauge the overall impact of Wilder's show in particular or of the "Mathematics" series in general, comments like these show that there were viewers who watched and appreciated educational television, even when it dealt with a topic as seemingly misunderstood and esoteric as mathematics. If airwaves are ephemeral, the archival record, in preserving at least this one show, has allowed us a glimpse at what, in the 1950s, was a new experiment in mathematical outreach.

Acknowledgments

As always, I thank Carol Mead and the staff at the Dolph Briscoe Center for American History at the University of Texas, Austin, for their invaluable help during my research trip to their archives. Thanks also go to Anne Johnson in Special Collections at the College of William and Mary, who graciously provided me with the image of Marilyn Kaemmerle, and to Albert Lewis, fellow historian of American mathematics and image wizard.

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[24] Ibid.

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