

# George Boole: The Man Behind “And/Or/Not”

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George Boole lived a quiet life in mid-nineteenth century Britain, but the influence of his work touches the lives of librarians and library users around the world daily as they search automated databases. This paper is a short biography of Boole.

FIND: Nineteenth-century English mathematician who was: [(clever or brilliant) and (good or kind)], not [(formally educated) or (wealthy or elite)]—and who could be a fine lion.

“Oh please, we are playing at lions and we want a good lion who can roar well. *Do* come and help!”<sup>1</sup> This appeal by the neighbor children was cheerfully granted by George Boole, whose young friends knew him chiefly as the kindly man next door who could be persuaded to leave his scholarly work to join in their games.

“He’s as innocent as a child, bless him! and as good as an angel; but I *never* should have guessed he was *clever!*” (“Home-side,” 32). This portrayal of Boole by an acquaintance is echoed throughout contemporary descriptions of him. His friends and colleagues were impressed by his virtue and the unassuming nature of this mathematical genius.

Many of us are familiar with Boole’s name, if not his talents as a roaring lion or angelic acquaintance. We regularly use Boolean operators (“and,” “or,” “not”) when searching automated databases. In this age of quarks and megabytes, the term “Boolean” invokes something out of the mind of some computer hacker, or perhaps out of the galaxies of science fiction. In fact, George Boole was a quiet, provincial Victorian Englishman with a passion for pure mathematics.

Although George Boole never saw a computer, he is often called “the father of computer science” for his contribution to the logic by which they work. Best known for his advocacy of the application of algebraic systems to nonmathematical reasoning, his work ultimately led to the application of binary mathematics in the programming of twentieth-

century computers, the system of pluses and minuses, yes's and no's, that is the basis of computer language and logic.

Though the passage of time has obscured the man behind the name, his experiences were unusual, and his biography can engage the interest of those who have never searched automated databases as well as those who regularly use Boolean operators. Born in 1815 in the northern English city of Lincoln, George was the eldest of four children born to John Boole and his wife Mary Ann. A shoemaker by trade, John Boole spent his days trying to satisfy his own hunger for an education, slighting his responsibilities in the shoe shop by indulging in the study of science and literature. He preferred to build telescopes and other optical instruments to mending soles. He also enjoyed a love of reading and even kept a French dictionary in one of the drawers in his workbench. John Boole also devoted time to volunteer activities in some of the town's humanitarian organizations. Thus, what might have been a fairly comfortable middle-class life for the family was one of constant struggle to make ends meet.

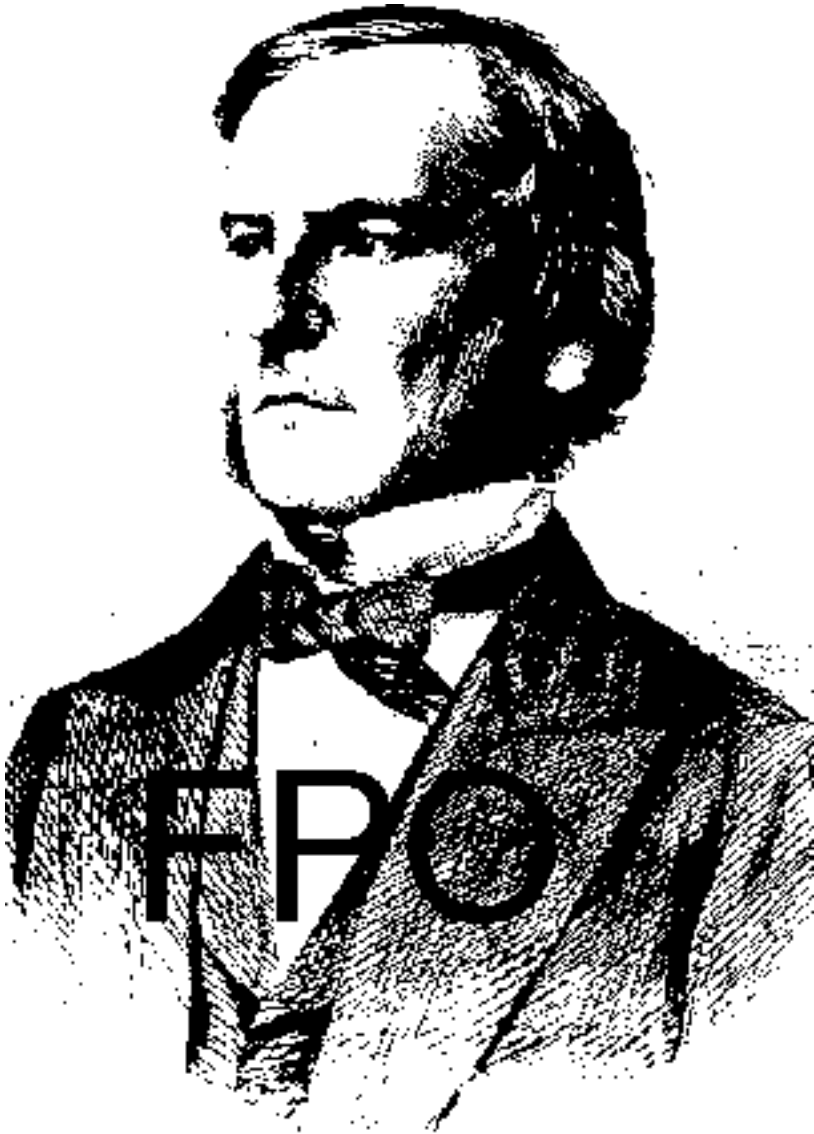
Though neglectful of his shop and trade, George's father was as attentive to his children's needs as his meager resources would allow. His disinterest in business matters gave him time to spend teaching his children what he had learned in his independent search for an education, so they grew up impressed by his love of learning, and, like him, they cherished knowledge—whatever the source.

He sent George to a dame's school when the child was only a year and a half old. The boy was unusually bright, and while still in skirts wandered into the town one day where he was found spelling big words for a crowd of townsfolk who threw him coins for his efforts. He was enrolled at age seven in a "commercial school" (whose emphasis was on practical business topics) and three years later went to a "primary school." At the latter he was remembered by a classmate:

we had no boy in the school equal to him, and perhaps the master was not, though he professed to teach him. This George Boole was a sort of prodigy among us, and we looked up to him as a star of the first magnitude.<sup>2</sup>

His brilliance made him neither arrogant nor haughty, however, and he was described by the same classmate as having a "shy and retiring disposition," a characterization that followed him throughout life.

By the time he was ten, George had exhausted his father's knowledge of the classical languages. The boy loved reading Latin and enjoyed translating the works of great classical writers into English. The bookseller William Brooke (a neighbor of the Boole family) was engaged to



*George Boole (1815–1864). (Engraving from *The Illustrated London News*)*

tutor George, who soon became proficient in Latin. In his early teens he studied Greek on his own, doing so well that his father proudly sent the local paper copies of some of the fourteen year old's translations. Upon their publication, a reader wrote to the editor expressing his doubts about the authenticity of George's work. After weeks of heated debates

carried on through the “letters to the editor,” the matter was settled in young Boole’s favor.

The study of the classics was part of the standard foundation of a good education in nineteenth-century England, but George’s eagerness to study Greek and Latin was enhanced by his plan (not uncommon among young Englishmen of his era) to go into the clergy. Even as a young boy he had a serious interest in religion, the natural outcome of his parents’ religious devotion, practiced within the confines of the Church of England. His extensive use of his tutor’s library in pursuit of this goal led, however, to his exposure to the literature of other faiths and in turn to his turning away from traditional Anglicanism. Deeply spiritual by nature, George continued his spiritual quest all his life. One contemporary claimed that “In his family and among his immediate friends he was looked up to as a religious teacher and guide rather than as an author and a man of science.”<sup>3</sup>

The shoemaker could not afford to provide formal education beyond primary school for his son, so in 1831 George took a position as a school “usher” (schoolmaster’s assistant) at a Wesleyan boarding school in Doncaster, forty miles from Lincoln. Only sixteen at the time, he taught elementary mathematics and Latin, while learning (chiefly on his own) to read French, German, and Italian. The move to Doncaster limited his free access to a good library, so (as he later recalled) he began shifting his studies from languages to mathematics “for the simple reason that he found it cheaper to supply himself with mathematical books than any others, since each treatise took a long time to read” (“Home-side,” 14). Although well-respected for his knowledge and teaching abilities at the school, he ran into trouble for expressing his growing difficulties with conventional Christian doctrine. The boys whom he taught, products of strict Wesleyan upbringing, reported his “heretical” views as well as his penchant for working mathematical problems during chapel services to their parents, who in turn complained to the school authorities. Boole was dismissed in 1833.

He moved on to short teaching stints at other schools, but soon decided to return to Lincoln, where his parents’ health and financial situation were declining. To support them, he decided to open a school of his own. Thus in 1834, when he was just twenty years old, he became proprietor of his own school and sole support of his parents. It was a small day school and, if not a great source of income, provided a situation that was ideal for George, who found time to study on his own as well as the freedom to put into practice his own ideas about pedagogical methods.

He used to insist on the necessity of proceeding from the particular to the general—from acts to principles. He told me, for

instance, always to require a child to work on a sum before I gave any explanation of the rule. They were to *obey* first and *understand* afterwards. He said that in the process of making a scientific discovery, you could never tell beforehand to what question you were going to find an answer. You set yourself a question, and presently found that you could not solve it without solving a much wider one. And when you had done so, if you wanted to give others the benefit of your discovery, you must not begin at once with the wider question; you ought to go back on your own track—start with something like the idea that first suggested itself to you, and lead them on in something like the way you yourself had been led. (“Home-side,” 5–6)

He carried his reverence for language into his teaching, stressing the importance of diction and inflection when teaching young children to read. He believed that “book education” should be supplemented with physical education for the good of both health and the mind, and that it was important to remain in communion with nature.

After a few years new opportunities arose on the work front, for in 1838 George was called to Waddington, where he had taught briefly just before opening his own institution. The authorities there invited him to replace the headmaster, who had recently died. The entire Boole family moved to the town (about four miles from Lincoln) and George and his siblings worked together to run the school, which was larger and provided more income than had George’s small day school. They remained in Waddington until 1840, when it became possible for George to purchase property in Lincoln to open his own school once again—this time a boarding school with more students than his previous Lincoln school had accommodated. The security of proprietorship was a big factor in this move, as George’s parents became more infirm and their needs greater.

George did not neglect his personal quest for learning while he worked to teach others. He had received a solid grounding in practical mathematics from his father and the commercial school. He now moved into the realm of pure mathematics, guided by the aforementioned slow-going treatises. The fact that he was largely self-taught was possibly one of the reasons for his own great creativity in the field; unhindered by conventional mathematical thought, he was free to be innovative. By the time he was twenty-three years old (1838), he had prepared his first paper, “On Certain Theorems in the Calculus of Variations,” although the first to see print was his “Researches on the Theory of Analytical Transformations, with a Special Application to the Reduction of the General Equation of the Second Order,” appearing in 1840 in the *Cambridge Mathematical Journal*. The journal’s young editor, Duncan Gregory, recognizing

the “diamond in the rough,” was both encouraging and helpful in guiding George to get his thoughts ready for a standard publication.

At about this time, friends suggested to George that he take a degree at Cambridge. Among those to whom he turned for advice on the matter was Gregory, who wrote that it would not only be very expensive, but that Boole would almost certainly find himself unhappy with the university’s requirements for a “great deal of mental discipline, which is not agreeable to a man who is accustomed to think for himself. A high degree here is due quite as much to diligent labour in certain appointed paths as to mathematical capacity.”<sup>4</sup> Ultimately, George decided not to attempt it.

Encouraged by the success of his 1840 paper, George began writing more for publication. A turning point in his career occurred when he was awarded a gold medal by the Royal Society (the first they had ever awarded for mathematics) in 1844 for his “On a General Method in Analysis.” In it, he had defined the concept of logical operators, influenced by his earlier study of languages and their structure. With the publication of this paper and subsequent celebrity among other British mathematicians, he began taking part in the “invisible college,” delving deeper into pure mathematics with the help of a growing body of correspondents who wrote to him on mathematical subjects.

In 1847, Boole published a pamphlet entitled *The Mathematical Analysis of Logic, being an Essay Toward a Calculus of Deductive Reasoning*, the core of his masterpiece. Boole’s biographer, Desmond MacHale, writes, “it is not extravagant to claim that much of the content and method of today’s so-called ‘New Maths’ stems directly from Boole’s book of 1847.”<sup>5</sup> In 1854, after seven years of revision and refinement, he republished it as *An Investigation of the Laws of Thought*, one of his most influential and permanent contributions.

The success of his papers and book encouraged George to apply for a post as Professor of Mathematics or Natural Philosophy in the Queen’s College system of Great Britain. In 1849 he was appointed to the first professorship of mathematics at the newly instituted Queen’s College in Cork, Ireland. This appointment was quite remarkable in its time, for George came neither from the social class nor the educational background usually required for such positions.

In 1850, one year after taking the Queen’s College appointment, he met his wife-to-be, Mary Everest. Mary, born in 1832, was the niece of Sir George Everest, the Surveyor-General of India for whom Mount Everest was named. As a very young child, Mary had discovered algebra. She had tutors who gave her instruction in mathematics at the level they deemed appropriate, but she was quite captivated by it and studied further on her own. She once recalled,

I have often told myself that I knew nothing about God except that he made Algebra, which I have always felt was quite sufficient reason for loving him with all my heart and soul, and doing as far as I could, whatever I thought he wished. As for his loving, that was obvious to me always. He had made me capable of understanding Algebra. I have always known that even Omnipotence could not have done that except by great love for me.<sup>6</sup>

She must have regarded George as heaven-sent, then, as well! They met while she was staying with her uncle John Ryall and his family, whom George often enjoyed visiting. Ryall, the vice-president of Queen's College, also held a professorship in Greek, and he and Boole were close friends. Twice as old as Mary (he was thirty-five, she eighteen when they met), George seems to have regarded himself only as an avuncular mentor for years, informally tutoring her in mathematics both in person and by correspondence. Aware of the difference both in their ages and social class, he was hesitant to move beyond this status. A change in her health and financial situation, however, finally gave him the nerve to ask her to marry him when she was twenty-three and he forty. Her father had just died, leaving her penniless and ailing. Most of what we know about George Boole's nonmathematical world comes from Mary Boole, with whom he shared nine years of what is reported by her as a marriage like "a sunny dream" ("Home-side," 21).

The happy couple became the parents of five daughters, each very bright in her own right. There is a story that, after the birth of their first child, George ran into the slums behind the college, knocking on people's doors, excitedly telling each inhabitant about the birth of the baby. "I had to come and tell you, dear friends: I've got a baby, and she is such a beauty!"<sup>7</sup> As the neighbor children had discovered, George loved children and enjoyed his own tremendously.

Lamenting his own lack of formal education, he wished his own children to receive a thorough schooling, although he expressed the realization that this would end the prospects of their showing originality. His beliefs about the education of females was closer to the orthodoxy of the day. While he had taught mathematics to his wife in her girlhood, he had regarded it more as a matter of interest than as lessons and insisted that his own daughters be encouraged only

in such occupations as are common to women in all ranks of life. . . . To be a good sick-nurse was always put before the children as the highest result of the best education, as the reward to which they should look for all the pains they took in learning. ("Home-side," 5)

Two years after his arrival in Cork, George was elected to the deanship of the Science Division of the Faculty of Arts. He also served on the College's Library Committee, including a stint as its chairman. He was commissioned to devise a plan for the organization and circulation of the books, which he did to the complete satisfaction of the other committee members. Books were classified according to their locations, and records of books lent were kept in ledgers. Among the more practical matters addressed during Boole's chairmanship was the need to close the library earlier on winter days because of the inadequate lighting in late afternoons and a concern that certain professors were keeping books too long. A decision made in 1851 to close the library during the summers was justified by an attendance record of only one patron per day during the previous summer. MacHale reports that

the Librarian of the day seems to have been subject to some pretty stringent restrictions. For example, he was required to be present at his desk between the hours of nine and five, and in addition he was responsible for the replacement of any lost or stolen books.<sup>8</sup>

As had his father, Boole took an interest in helping develop the cultural and educational attainments of working folk. On the home front, he required his daughters to help the servants with their work and disapproved of families in which the mothers were "slaves" of their offspring. "Selfishness is worse for their health than little hardships" ("Home-side," 33). Among his organized charitable efforts, he was most involved with the Lincoln Mechanics' Institute (a combination trade union and workers' education society), giving free lectures on the classics and mathematics, helping to form their museum and three thousand-volume library and serving a stint as the group's director. He also read papers at meetings of the Cuvierian Society (formed originally to study natural history but branching out to other aspects of the sciences) and served as its president in 1854. He also served as a vice-president of the Early Closing Society (organized to press for shorter shop hours for the health of employees) and was a founder and trustee for the Lincoln Female Penitents' Home (established in 1847 for former prostitutes). He was not afraid to go into the slums and showed considerable empathy for those who lived there. Robert Harley, Boole's close friend and first biographer, wrote, "His intense devotion to the exact sciences did not contract the affections of his heart, or damp the ardours of his devout and generous soul; the *man* was not lost in the mathematician."<sup>9</sup>

Despite his sociability, Boole was by nature solitary, taking his nourishment from the life of the mind. Thus his wife recalled that, although “considered a great acquisition at picnics and Balls” and “able and willing to talk to anyone on his or her special subjects” (“Home-side,” 16), “he . . . never could bear . . . to be very long in any one’s society. Solitary meditation seemed as necessary to him as food—more so than sleep” (“Home-side,” 17–18). He was very popular with his students, who would invite him along on their outings. He often accepted their invitations but would occasionally forget to show up. “I heard many funny stories about his absence of mind” (“Home-side,” 18). Sometimes he was so engrossed in his thoughts that nothing around him could intrude. Once, an entire class came to their lecture, only to find George deep in thought in the classroom. After waiting for some time, they silently left. George never saw them and came to the conclusion that nobody had come to his lesson.

He was revered not only by his own family but by his students and colleagues. Mary reports that one of his students said that when he was lecturing, “he looked, not like a professor writing a demonstration on a blackboard, but like an artist painting from a vision.”<sup>10</sup> Harley wrote,

His teaching in the class-room was thorough and efficient. He possessed, in a remarkable degree, the power of communicating knowledge; he condescended to the meanest capacity waiting even on dulness [*sic*], and adapting his instructions to the average intellect of his pupils. The affectionate interest which he showed in their welfare, endeared him to their hearts, and in a very short time, he had become an immense favourite among them. By his colleagues also he was esteemed and beloved; they recognised his merits, and felt that he was a man with whom it was an honour to be associated.<sup>11</sup>

His colleagues both at the college and farther afield recognized what a treasure they had in George. In 1852, the University of Dublin awarded him an honorary LL.D. His paper entitled “On the Application of the Theory of Probabilities to the Question of the Combination of Testimonies or Judgments” garnered for him the 1855–1857 Keith Prize—the highest honor awarded by the Royal Society of Edinburgh for a “communication” on a scientific subject sent to the society. In June 1857 the society elected him a Fellow. Awards followed one after the other; a year later, he was elected an Honorary Member of the Cambridge Philosophical Society and in 1859 Oxford University awarded him an honorary D.C.L. At the ceremony surrounding this last award, George followed a

group of well-known English heroes from India, and the undergraduates' wild cheers for the Indian superstars went silent for the relatively unknown mathematician now standing before them. This was of no consequence to George, who worked for the intrinsic worth of his toil, not for glory.

George had begun writing mathematics textbooks but found it difficult to express concepts in the simpler language needed by novices. At the suggestion of a publisher, he asked Mary to assist him by helping him see where there was a need to make things clearer to the nonspecialist. He invited her to attend his senior lectures as part of the textbook project, but local society so openly disapproved of a woman's presence in the all-male classes that Mary came only to a few weeks' classes. She found allies, however, in George's students, who had grown to like her. They elected to reorganize their classes at the Booles' house, off college property, so Mary could continue to meet with them and continue to help develop examples to be included in his textbooks. In 1859 he published *A Treatise on Differential Equations*, a text used at Cambridge and even consulted today in revised editions. The following year he published another textbook, *A Treatise on the Calculus of Finite Differences*, a work still in print. Boole continued his scholarly research, publishing papers in French and German as well as English.

The love of clarity, harmony, and order that informed his love of mathematics also shaped his personal and religious life. Both Mary and George had grown up in the Church of England (Mary Boole's father was a clergyman), and the Booles had all five daughters baptized in the Anglican Church of Ireland. For social reasons, George attended Anglican services, but he was still searching. He visited all sorts of denominations, his beliefs falling more in line with those of Unitarians than any other established denomination, though he never formally joined a congregation. His wife reported often hearing him say that "once a man thinks himself bound to a settled creed, it seems as if truth, faith and charity become impossible to him, except in so far as he evades his creed" ("Home-side," 3). He would tolerate no jokes made about others' beliefs. "Prayer and labour, he often used to say, are the salvation of mankind" ("Home-side," 4). "The immortality he cared for was not endless existence, but the conviction that while he lived his mind would be in contact with truths that are eternal" ("Home-side," 7). He believed people should concentrate on living a moral life for the sake of living morally and should work on improving this world. He grew angry whenever the subject of the clergy's contempt for science was brought up. "His reverence for science amounted to nothing less than worship. . . . But he constantly assumed that moral laws and spiritual relations were

intended, not indeed to over-ride, but to use and govern, physical facts. . . ." ("Home-side," 26).

Harmony and order were important in Boole's religious life. He really enjoyed religious services, but only if they were done very well.

Bad singing in a respectably dressed congregation, loose, hasty expressions in a sermon, or bad reading by an educated clergyman, he seemed to consider little short of a crime. . . . but he was nowhere happier than in little village chapels, where the people spoke reverently in their own dialect and sang fervently the best tunes they knew. (17BM)

Harmony and order also played a central role in his family life. Always loving peace and quiet, George walked away from familial conflict rather than confronting it. He walked out of the house during his wife's "explosions of temper," and when a daughter had a tantrum, he picked up the child and removed her from the situation. Once he told his wife,

nothing was so important to children's welfare as harmony between their parents; and that no educational advantage that a mother could procure for her child could ever compensate for the injury which she inflicted on it by indulging for a moment any feeling of irritation against its father before its birth. ("Home-side," 23)

George seems to have treated Mary like a child in some ways, but he tolerated her burning his poetry and forbidding him to speak of college matters off campus. "When once he made me clearly understand," Mary Boole recalled, "that he intended to tolerate no interference with either his religion or his work, he was as docile as a lamb about everything else" ("Home-side," 23). Thus Mary played the good Victorian wife, attending to the needs of her pliant spouse. "I had undertaken the care of his health and brain," she said.

It would no more have occurred to him to resent my forbidding particular topics of conversation, or particular modes of recreation, than his doctor forbidding particular articles of diet. This clear understanding of the claims of responsibility to respect, ran through all his domestic relations. ("Home-side," 24)

His death came suddenly. Walking the two miles from home in Ballin-temple to the College on 24 November 1864, in a pouring rainstorm,

George was soaked. Rather than coming late to the classroom, he lectured in his wet clothes and subsequently came down with a bad cold. This sent him to bed with a fever, and his lungs were affected. After two weeks of feverish illness, he died on 8 December.

He was just forty-nine years old, and at the height of success in his professional life, beloved by his students and colleagues, and admired by his peers. His students came in great numbers to walk in the funeral procession wearing their academic regalia, and townspeople and other friends donated funds to purchase a stained-glass window (including a panel showing Boole at work), which was placed in the Cathedral Church in Lincoln. He was eulogized both at home and beyond. The *Times* wrote of him as

One of those men known to a limited circle, but within that circle the object of an affectionate respect approaching to veneration . . . [yet what] most marked him out from his fellows was an intellectual modesty such as he once described as “inseparable from a pure devotion to truth.” . . . [H]e appeared absolutely insensible to his claims upon the attention of others.<sup>12</sup>

The Cuvierian Society paid this tribute:

An able writer and expounder of the highest branches of human learning, with a world-wide reputation, Dr. Boole’s unassumed humility endeared him to all, for he was humble even as a little child . . . Cut off in the meridian splendour of a life devoted to a career of usefulness both in public and private, the country of his birth mourns for him, the land of his adoption looks down with sorrow upon his tomb.<sup>13</sup>

George had had neither family resources nor time to build any retirement funds, and attempts by his friends to get the government to provide his widow a pension were unsuccessful. She was eventually rescued from certain poverty when she was offered the position of librarian at the all-female Queen’s College, London, a post created especially for her. In addition, she ran a boarding house for some of the students until 1873, when her eccentric behavior and views led to the termination of her lease. She continued to earn a meager living working as a private secretary. She also continued an exploration into human psychology, homeopathic medicine, and educational philosophies begun before her husband’s death, writing extensively about her own theories. All five daughters grew up to reflect their parents’ extraordinary intelligence and

exceptional creativity, some of them having careers in mathematics and science themselves.

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## Notes

1. Mary Everest Boole, "Home-side of a Scientific Mind," in E. M. Cobham, ed., *Mary Everest Boole: Collected Works*, vol. 1 (London: C. W. Daniel Company, 1931), 33. Subsequent references to this work will be noted in the text as ("Home-side," page number).
2. R. R. H. Harley, "George Boole F R S: An Essay Biographical and Expository," *British Quarterly Review*, no. 87 (2 July 1866): 143.
3. *Ibid.*, 171.
4. D. F. Gregory to G. Boole, 29 March 1840, quoted in Desmond MacHale, *George Boole, His Life and Work* (Dublin: Boole Press, 1985), 53.
5. MacHale, *George Boole: His Life and Work*, 71.
6. Mary Everest Boole, "A Child's Idyll," in E. M. Cobham, ed., *Mary Everest Boole: Collected Works*, vol. 4 (London: C. W. Daniel Company, 1931), 1524.
7. Geoffrey Taylor, "George Boole 1815–1864," *Proceedings of the Royal Irish Academy*, B ser., 67 (1955):68.
8. MacHale, *George Boole: His Life and Work*, 102.
9. Harley, "George Boole F R S: An Essay Biographical and Expository," 151.
10. Mary Everest Boole, "Mount Carmel in London," in E. M. Cobham, ed., *Mary Everest Boole: Collected Works*, vol. 1 (London: C. W. Daniel Company, 1931), 76.
11. Harley, "George Boole F R S: An Essay Biographical and Expository," 159.
12. "The Late Professor Boole, F.R.S.," *The Times*, 14 December 1864, p. 10, col. c.
13. [Report from Ireland], *The Times*, 23 January 1865, p. 10, col. c.