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MATHEMATICAL QUESTIONS: A CONVERGENCE OF MATHEMATICAL PRACTICES IN BRITISH JOURNALS OF THE EIGHTEENTH AND NINETEENTH CENTURIES

Sloan Evans Despeaux

Abstract. — The persistence and wide-ranging popularity of the "questions and answers" genre in British journals during this period can be viewed as a convergence of two different mathematical practices: (1) the avocational, problem-solving tradition with roots in the dynamic almanac market of the eighteenth century. (2) the problem-solving tendencies and tastes of Cambridge graduates and the students of these graduates. These tendencies and tastes were encouraged through the conversion of the Cambridge Tripos to a paper-based examination at the turn of the 19th century and the subsequent diffusion of paper-based examinations throughout Britain during the second half of the 19th century. The convergence of these two practices resulted in the persistence of a particular method for mathematical communication and discovery that resisted the stratifying forces of social class, and later, professionalization. This paper will trace the "questions and answers" genre from its beginnings at the turn of

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the eighteenth century, to 1918, when the *Mathematical Questions . . . from the "Educational Times"* ended.

Résumé (Questions/réponses dans les périodiques britanniques des xviii^e^ et xix^e^ siècles : un genre éditorial à la croisée de deux pratiques mathématiques)

Les questions / réponses constituent un genre éditorial mathématique trés populaire en Grande-Bretagne aux xviii^e^ et xix^e^ siècles. Ce genre peut être analysé comme réalisant la convergence de deux types de pratiques mathématiques distinctes : (1) une certaine forme d'amatorat mathématique basée sur la résolution de problèmes et qui participe du dynamisme du marché des almanachs au xviii^e^ siècle (2) la tradition des problèmes courts posés aux étudiants lors de l'examen du Tripos à Cambridge. Cette tradition évolue profondément lorsque le Tripos passe d'un examen oral à un examen écrit. Durant la seconde moitié du xix^e^ siècle, les problèmes posés au Tripos sont alors diffusés dans toute la Grande-Bretagne. De la convergence de ces deux pratiques a résulté une méthode spécifique de communication et de découverte mathématique. Cette méthode s'est maintenue sur le temps long malgré les dynamiques de stratification des classes sociales, et de professionnalisation des mathématiques.

Cet article analyse les évolutions du genre éditorial des «questions / réponses» de son apparition au tournant du xviii^e^ siècle, jusqu'à la disparition, en 1916, des *Mathematical Questions . . . from the "Educational Times"*.

1. INTRODUCTION

In an 1880 review of mathematical journalism, Cambridge mathematician J.W.L Glaisher (1848–1928) described an evolutionary process that he considered common to all countries:

> first, there is the Annual or other periodical, containing at the end puzzles, problems for solution, &c., the best solutions and the names of those who sent in correct solutions being given in the following number; at length these are supplemented by short articles on particular subjects — frequently suggested by the problems — by the leading contributors. The next step is the mathematical journal, consisting of two parts, the one containing original papers, and the other — quite distinct — containing a limited number of problems and solutions. Finally we have the strictly scientific journal, differing in no essential respect from the Transactions of a society. [Glaisher 1880, 74]

Glaisher considered Britain to have passed through all of these phases, ending with the 1865 foundation of the *Proceedings* of the London Mathematical Society. However, the establishment, activity, and dissolution of these journals was not simply a progressive, evolutionary process. As British mathematicians embraced new journal formats, they did not spurn

the previous ones. In fact, the questions and answers format, the very first step in Glaisher's progression, remained viable and popular throughout the nineteenth century.

We will trace the questions and answers genre in Britain from its non-academic, almanac-based beginnings at the turn of the eighteenth century to the end of the nineteenth century, when a mathematical journal completely devoted to this genre enjoyed support from devoted contributors who defied the boundaries being created by the processes of professionalization and stratification. The persistence and wide appeal of this genre can be attributed to a convergence of two practices: one, an avocational, problem-solving tradition dating from the eighteenth century, and the other, a taste and training for problem solving cultivated through the paper-based mathematics examinations that infiltrated all levels of British education during the nineteenth century. Three case studies will provide insights on mathematical journals from different centers of support. We will also provide contemporary evaluations of the genre and a brief overview of the presence of this genre internationally.

2. THE *LADIES DIARY* AND ITS FOLLOWERS

Almanacs gave mathematics its first foothold in the British commercial journalistic sphere. "Ready reckoners," that is, mathematical calculation aids, appeared in the almanac *Poor Robin*, which ran from 1663 to 1828.[1] General mathematical questions could be found among the "between eight and fifteen questions on the broadest range of subjects" submitted by readers and answered by the editors of the bi-weekly newspaper, *The Athenian Mercury* from 1691 to 1697. [Berry 2003, 19][2] A mathematical home more substantial than *Poor Robin* and longer lived than *The Athenian Mercury* was the *Ladies' Diary*, initially established in 1704 as an almanac with articles for homemakers. However, by 1708, it had replaced many of

1 For more on this long running almanac, see [Wardhaugh 2012a].

2 For an example of some of the mathematical questions found in the *Athenian Mercury*, see [Wardhaugh 2012b, 109–113]. Berry states that John Dunton(1659–1732), the *Mercury*'s editor, should without a doubt be considered the founder of the literary genre of the question-and-answer periodical. [Berry 2003, 35].

its domestic features with mathematical ones in response to some of its readers, who had, of their own accord, submitted mathematical questions to the editor. [Costa 2002b, 52] By this time, the almanac tradition was already well established and extremely popular: even in 1660, for example, its circulation numbered between 300,000 and 400,000. Its focus on mathematics differentiated the *Ladies Diary* from the other almanacs, but it shared with the others a low cost that guaranteed a wide accessibility. [Costa 2002b, 49, 56] While this cost, three pence, was inexpensive, it was 50% more than the other almanacs offered by the Company of Stationers, a trade association that monopolized almanac production at the time. [Albree & Brown 2009, 12–13] Henry Beighton (1686/7 -1743), who edited the *Diary* from 1714 to 1743, appealed to the ability of mathematics to improvement the mind to give "the *Ladies' Diary* moral buoyancy on the sea of popular print." [Costa 2002a, 215]

A typical issue of the *Ladies' Diary* contained:

> 48 pages, the first 16 contained a preface, usually unsigned; a list of eclipses for the year compiled by various contributors; and a calendar for the year with a diary of notable anniversaries and holy days, and the differences between dial and clock times. There followed 4 or 5 pages of solutions to the previous year's Aenigmas, 13 or 14 pages of solutions to the mathematical questions, 12 or 13 pages of new puzzles and questions, a page containing a summary list of contributors with the numbers of the questions they had solved, and a page of advertisements. The Aenigmas, or word puzzles, were proposed and answered in verse, and sometimes included one in Greek, Latin, or French. At first the mathematical questions were set in verse and answered partly in the same way. However, after 1730 some prose questions appeared, and by 1745 they predominated. The name of the solver of a problem was given at the head of the solution; at the end there often appeared the names of other solvers, sometimes as many as 30. [Wallis & Wallis 1980, 58]

This format proved to be successful: by 1750, the *Ladies Diary* enjoyed a circulation of 30,000 and remained among the top five sellers for the next fifty years. [Costa 2002b, 52] The popularity of the journal's format sustained it for 136 years[3] and inspired scores of similar journals throughout

[3] For a selection of questions posed and published in the *Ladies Diary* over its long lifetime, see Appendix A in [Albree & Brown 2009]. For two more examples of questions from the early years of the journal, including one posed by a woman, see [Perl 1979, 39–40].

the eighteenth century (see Appendix A). Many of these journals copied the annual, almanac format of the *Ladies Diary*. For example, a committee of eight men, including Nottinghamshire land surveyors, John M. T. Badder (b. 1720–1756), George Ingman (b. 1725– a. 1776), and Thomas Peat (d. 1780),[4] began the *Gentleman's Diary* in 1741. [Taylor 1966, 164, 197, 209] While its format was that of the *Ladies Diary*, this new enterprise put a stronger emphasis on mathematics through its subtitle ("containing many useful and entertaining Particulars peculiarly adapted to the ingenious Gentlemen engaged in the Study and Practice of Mathematics"), more difficult problems, and more pages devoted to mathematics. [Albree & Brown 2009, 21] The popularity of the *Diary*s also created a market for supplements: *Diary* editors as well as other enterprising compilers created collections of past problems (such as *Diarian Repository* and the *Diarian Miscellany*) or provided space for overflow material (such as the *Supplement to the Gentleman's Diary*).

The demand for mathematics in the periodical press also encouraged the creation of journals containing mathematics that appeared more frequently than the almanacs. Enigmas, rebuses, and charades were often the companions of mathematical problems in these serials. Appendix A catalogs information about the existence of these puzzles as well as other features common to the journals. One such feature, a junior mathematical section, was often paired with literary sections containing French and Latin excerpts for translation in order to appeal to a student readership. In spite of their many features, these journals tended to have much shorter lives than the almanacs. For example, Edward Cave, founder of the general interest periodical, the *Gentleman's Magazine*, launched in 1745 the *Miscellanea Curiosa Mathematica* "in order to satisfy his mathematical correspondents, who were beginning to request too much space in the *Gentleman's*." [Carlson 1938, 25]. However, costs associated with the meticulous editing, proofreading, and printing of mathematics caused the *Miscellanea Curiosa* to cost more than its parent journal and end after fourteen numbers.

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4 Peat continued editing the *Gentleman's Diary* alone from 1757 to 1780. He also simultaneously edited the satirical almanac *Poor Robin*. For more on this almanac, see [Wardhaugh 2012a].

Controversy proved to be a strong catalyst for the proliferation of journals containing mathematical questions and answers. Robert Heath, editor of the *Ladies Diary* from 1745 to 1753, disagreed with the monopoly of the Company of Stationers on almanacs and clashed with many *Diary* contributors in his support of the use of infinitesimals in the calculus. As a result, he founded *The Palladium* in 1749 and *The Ladies Philosopher* in 1752, and he managed to publish them without the oversight Company of Stationers or the required Stamp Tax.[5] In response to Heath's perceived mismanagement of the *Ladies Diary*, John Turner, Thomas Simpson (1710–1761), and Edward Rollinson began the *Mathematician*; after this journal failed after six annual numbers, Turner continued with the *Mathematical Exercises*. In 1754, after he was removed as editor from the *Ladies Diary* under suspicion for shunting *Diary* material into his own publications, Heath started the *The Ladies Chronologer*. Turner ended the *Mathematical Exercises* after Simpson was appointed as Heath's replacement for the *Ladies Diary*; Rollinson served as the *Diary*'s subsequent editor. [Albree & Brown 2009, 18–19], [Archibald 1929, 381] Publisher Thomas Carnan (d.1788) also opposed the Company of Stationers monopoly on almanacs, but he appealed to the courts instead of employing Heath's questionable tactics. Carnan's legal success resulted in *The Lady's and Gentleman's Diary, or, Royal Almanack*, edited by Reuben Burrow (1747–1792), a mathematical contributor to the *Ladies Diary* and the *Miscellanea Mathematica*. Carnan's almanac appeared, beginning in 1776, for thirteen annual volumes and spawned at least three supplements. Besides this almanac, Carnan was publishing at least thirty others two years after the court's 1775 ruling. The Stationer's Company, however, soon regained the upper hand when the Stamp Tax was doubled a few years later. This higher tax, which again doubled in 1797, successfully discouraged competitors. [Wardhaugh 2012a, 142–143], [Archibald 1929, 389], [Blagden 1961].

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[5] The first British tax on almanacs was enacted in 1710 both to raise government revenue and to suppress what the government felt was incendiary speech in the press. This tax on almanacs continued in different forms throughout the eighteenth century until it was abolished completely in 1834. [Siebert 1965, 308], [Blagden 1960, 242]

2.1. *Demand that fueled the supply: Students, ladies, and philomaths*

Who provided the demand for mathematics in print that fueled such a lively and dynamic publication milieu? The widespread use of pseudonyms in these journals makes any answer to this question less than definitive. This practice of using pseudonyms was common during the eighteenth century, and was carried on into the nineteenth century. In his investigation of the *Cambridge Mathematical Journal*, Tony Crilly has pointed out that "It was the material presented which was important and it was a matter of social form that the author should not draw attention to himself for self-advertisement… [Aliases] enabled an author to try out an idea without risking personal criticism from a critical readership and undergraduates published anonymously presumably under the principle that they could be heard but not seen." [Crilly 2004, 466]

In spite of pseudonyms, subscription lists, the published names of problem posers and solvers, and the formats of the journals themselves can help us approach the answer to this question. For example, the junior mathematics feature of many of these journals implies that students formed at the very least a target audience for editors. In fact, in his investigation of the *Gentleman's Diary*, Olaf Pedersen wrote that the journal "to a certain extent may be regarded as an organ for elementary school mathematics where skillful pupils were allowed to publish their first results, probably encouraged or sponsored by their masters." [Pedersen 1963, 248] This student audience migrated to other journals as the difficulty of the problems increased. For example, the first volume of the *Northumbrian Mirror; or, Young Student's Literary & Mathematical Companion, Forming an Introduction to the Ladies' Diary, &c.* in 1837 claimed that the *Diary*s and the *Gentleman's Mathematical Companion* "are fitted only, or chiefly at least, for adepts in mathematical science. The juvenile mathematician can scarcely dare to enter their renowned lists." [Anonymous 1837, iv]

Like students, the role of women in these journals changed over the years. Although the *Ladies Diary* sought to set itself apart from the other almanacs by appealing to the "fairer sex," women did not form the majority of the contributors. In her investigation of gender in the *Ladies Diary*, Shelley Costa acknowledged mathematical contributions to the *Diary* by

women ranged between 2 per year to 12 per year for selected years between 1711 and 1724 (this comes to 11.4% of all acknowledged contributions for these selected years); however, the actual number of women corresponding with the editor was many times this number. Costa described a process beginning in the 1720s that changed the *Diary* "from a forum where women's 'geometrical, algebraical, astronomical and philosophical' skills[6] were displayed and praised to one nominally dedicated to women and to mathematics, but in which polite banter had been displaced by an increasingly skill-oriented, even confrontational, discourse." [Costa 2002b, 70] Questions posed in rhyming verse were replaced by those set in prose, figures, and equations. "With these changes, contributing mathematically to the *Ladies' Diary* lost the surface characteristic of 'polite accomplishment' that it had formally shared with acceptably feminine activities such as music, dancing, horseback riding, and poetry." As a result of this change, "women dropped out of its mathematical dialogue for more than twenty years, resurfacing [by mid-century] only in very reduced numbers and in a much more competitive context." [Costa 2002b, 71–72][7]

In their discussion of the *Ladies Diary*, Ruth and Peter Wallis described its male contributors as "not generally university educated, but rather the practitioners, many self-taught, whose work involved a knowledge of mathematics. In this category are included teachers, surveyors, carpenters, engineers, makers of sundials, instrument-makers, and seamen." [Wallis & Wallis 1980, 60] Many of this group, who approached mathematical study as an

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6 In her study of the *Ladies' Diary*, Teri Perl found that most of the contributions by women concerned algebra, geometry, and indeterminant analysis, topics more accessible to women, who were more than likely self-taught or taught informally. [Perl 1979, 44–45].

7 Ruth and Peter Wallis note several eighteenth-century mathematical texts specifically addressed to women, such as Robert Heath's 1752 *Truth Triumphant: or, Fluxions for the Ladies* [Heath 1752] and John Newberry's 1761 *The Newtonian System of Philosophy Adapted to the Capabilities of Young Gentlemen and Ladies*. They also found women among the subscriber lists of other mathematics texts and ladies explicitly included in the publicity for scientific lectures. Thus, although female contributors to the *Ladies Diary* waned, "[t]here seems little evidence either from book titles or lecture publicity that expectation of female interest in science and mathematics diminished over the [eighteenth] century." [Wallis & Wallis 1980, 61–62]

avocation, would have described themselves as "philomaths," a term popularly used in the seventeenth and eighteenth centuries. [Wallis & Wallis 1980, 58] Pedersen examined the *Gentleman's Diary* from 1741 to 1759 and estimated there were around 240 philomaths who contributed to the journal for these years; in a follow-up examination, Peter Wallis used subscription lists to argue that this number was "significantly greater." [Pedersen 1963, 241], [Wallis 1973, 302] Pedersen emphasized that the contributorship, and philomaths in general, crossed economic class boundaries and included teachers and pupils, men who used mathematics in their jobs, and "Gentlemen Scientists." [Pedersen 1963, 254]

Looking at the questions for this period in the *Gentleman's Diary*, Pedersen found that they "showed a marked predilection for questions in elementary geometry, including stereometry,[8] gauging[9] and conic sections,[10]" and that the authority they cited the most was Euclid. In this emphasis on geometry, "the Philomaths simply continue a very old tradition which was to dominate mathematical teaching [in] England for still another century and a half." [Pedersen 1963, 243][11]

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8 For example, Question 4 for 1741 by a Mr. W— B— stated "What's the greatest Solidity possible of that square Pyramid, whose slant Side is = 60 Inches? and the other Dimensions?" [Anonymous 1741, 31]

9 For example, Question 127 for 1753 by a Mr. William Bevil stated "There is given the Head Diam. of a spheroidal Cask = 32 Inches, the Bung Diam. = 40, and the Content of its greatest inscribed Cube in Wine Gallons to its greatest inscribed Cylinder in Ale Gallons as 1 is to $1\frac{39}{50}$. Required the Length and Content of the Cask, with the Investigation of the same?" [Anonymous 1753, 44]

10 For example, Question 172 for 1756 by Mr. Charles Wildbore (an editor of the *Diary*) described "A *French* Man of War, spying an *English* Frigate at a Distance, bore down upon it, and coming within half a Mile, saluted it with her chase Guns; which the *English* then, making all the Sail they were able, returned with broad Sides: in this Manner they bore away, with an uniform Celerity; (the Velocity of the *English* being to that of the *French* as 5 to 4) always keeping at the same Distance from each other, till the *French* were 10 Miles from the Place where the Chase began, when the *English* steer'd away, and the *French*, despairing to come up with them, gave over the Chase. Now it was observed that the *French* Ship described a semi-parabolic Curve, whose Abscissa is 8 Miles: it is required from hence to determine the *Nature* and *Length* of the Track described by the *English*?" [Anonymous 1756, 40–41]

11 Geometry featured prominently in the *Ladies Diary* as well. Out of 1930 problems from 1708 to 1840 categorized in [Albree & Brown 2009], 885 (45.9%) were categorized as geometrical. The categorization for 1708 to 1816 was performed by

3. PHILOMATHS FROM THE NORTH OF ENGLAND AS ACTIVE CONTRIBUTORS AND EDITORS

One group of philomaths devoted to this geometric tradition came from a seemingly unlikely source: the mills, mines, and fields. Historian and mathematical contributor Thomas Turner Wilkinson (1815–1875) described this group, especially those from the North of England, in a series of articles in the 1840s and 1850s. He speculated why this group had been so fascinated with geometry:

> The weaver at the loom, — the farmer in the field, — the mechanic in the shop, — or the miner in the drift, is too much occupied by *manual* labour to be able to *write out* long *analytical* investigations, but each can contemplate and deduce at pleasure the properties of a geometrical diagram, either *actually* constructed or mentally conceived. The farmer and the miner soon acquire the power of depicting vivid *mental* representations of the constructions necessary for their geometrical inquiries, and are thus enabled to carry on their processes of deduction even when buried in the mine or following the plough. The weaver and the mechanic can sketch their diagrams on a slate, and thus pursue their favourite studies whilst their hands and feet are almost instinctively engaged in their monotonous operations. [Wilkinson 1854, 130]

In his 2001 study on the British working classes, Jonathan Rose provided other motivations for the intellectual curiosity of weavers and miners, especially in Scotland:

> Weavers and lead miners were well-paid and had short work hours: six hours a day for miners, four days a week for weavers. Weavers had to be literate for their work, and mining companies wanted an educated work force. Both trades had a history of friendly society activity and self-education. [Rose 2001, 59]

Regardless of the reasons for their interest in mathematics, these working-class men began to form societies for their avocational, mathematical interests by the second decade of the eighteenth century. The

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Thomas Leybourn in his republication of the *Ladies Diary* for those years; Albree and Brown performed a similar categorization for the remaining years. In this categorization, geometry was broken down into Geometry problems resolved by Pure Geometry (11.7%), by Algebra (16%), by Arithmetic (6.3%), by the Arithmetic of Sines (0.5%), relating to Maxima and Minima (8.1%), and Geometrical Theorems (3.3%). Other popular categories were Algebra (8.5%), Astronomy (8.2%), and Dynamics (8.9%). [Albree & Brown 2009, 40–42]

Spitalfields Mathematical Society was founded in 1717 and originally consisted of men seeking an intellectual recreational break from a hard day's work, each with "his pipe, his pot, and his problem." [De Morgan 1915, 376–377] At mid-century, of the members, "about half were weavers and the rest were typically Brewers, Braziers, Bakers, [and] Bricklayers." [Cassels 1979, 242][12] In 1718, the Manchester Mathematical Society was founded by working class men from Northern England with a strong interest in geometry. In 1794, the Oldham Mathematical Society was similarly established.[13] This group flourished into what Wilkinson described as the Lancashire School of Geometers.[14] The products of this school were largely found in questions and answers of mathematical journals. Mathematician and journal editor Thomas Stephens Davies (1795–1851), in his own account of this school, noted that while the annual format of the eighteenth-century almanacs provided only limited space for these men to display their talents:

> the spirit of emulation did something; from the belief that *insertion was an admitted test of superiority*, it was as much an object of ambition amongst these men to solve the "prize question" as it was by philosophers of higher social standing to gain the "prize" conferred by the *Académie des Sciences*. [Davies 1850, 437]

For these men, well outside of the university sphere, Latin mathematical texts were useless. In the 1740s, English textbooks on algebra and geometry by Thomas Simpson (who at the time was editing the journal the *Mathematician* and who would later edit the *Ladies Diary*) helped fill the void

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12 In time, the members of the society became more bourgeois and began offering public lectures on a variety of subjects. However, by the 1840s, its membership was flagging, and in 1845 it was absorbed into the Royal Astronomical Society. In 1866, Augustus De Morgan compared the Spitalfields Mathematical Society to the new London Mathematical Society, of which he served as the first president: "not a drop of liquor is seen at our meetings, except a decanter of water: all our heavy is a fermentation of symbols; and we do not draw it mild." [De Morgan 1915, 383]

13 In 1850, T.S. Davies described this society as having "generous co-operations, and there was keen competition, — the sure stimulants to eminent success." [Davies 1850] Besides those centered at Spitalfields, Manchester, and Oldham, mathematical societies sprung up around the middle of the eighteenth century at Lewes, Wapping, and York. [Cassels 1979, 253–254]

14 See [Brierley 1878] for short biographies of 59 Lancashire mathematicians who contributed to question-and-answer journals.

for instructional material. In Wilkinson's opinion, however, "the most active elements at work were undoubtedly the mathematical periodicals of the time." [Wilkinson 1851, 58]

The cases of James Wolfenden (1754–1841), John Butterworth (1774–1845), and John Kay (1781–1824) provide insight into the education, occupation, motivation, and mathematical output of the Lancashire School. As a child, Wolfenden was taken out of school after only one week, "the bobbin-wheel and the loom being considered much more profitable employments than learning to read." [Wilkinson 1849a, 387] With the help of his grandfather, as well as that of local mathematician Jerimiah Ainsworth (1743–1784), co-founder of the Oldham Mathematical Society, Wolfenden began to pose and answer mathematical questions in Burrow's *Diary* in 1781. Wolfenden continued to contribute solutions and questions (many of them prize questions) for almost sixty years to the *Diary*s, the *Mathematical, Philosophical, and Geometrical Delights*, the *Student* (published by his own pupil, William Hilton (1772–1826)[15]), the *Gentleman's Mathematical Companion*, and the *Mathematical Associate*. In his memoir of Wolfenden, Wilkinson reprinted letters from journal editors Thomas Leybourne (c. 1769–1840), John Henry Swale (1775–1837), William Davis (1771–1807), and Hilton, who all implored Wolfenden to propose or answer difficult questions. [Wilkinson 1849a] Wolfenden gave up his hand loom at the age of 62 and began tutoring students in mathematics.

Like Wolfenden, John Butterworth pursued mathematics under detrimental economic conditions. Butterworth served as one of the subjects in the 1873 account of scientists in "humble life" by amateur botanist and Manchester journalist, James Cash.[16] Butterworth's biography highlights the crucial role mathematical periodicals played in his formation as a mathematician:

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15 A obituary of Hilton details that he studied under Wolfenden on Sundays, "and appears to have carried his studies to his work at the loom, for it is said that often when the picking-stick should have been going, William was found sitting aside from his work, thinking and figuring out some abstruse problem." After solving a difficult problem on tides "Mr. Knowles [the first editor of the *Student*] arrived at the home of William in his carriage, and took him in triumph out of his loomhouse … to Liverpool." [Philander 1882, 337–338]

16 For more on the self-taught naturalists of Lancashire, see [Percy 1991].

> His first taste for mathematics was obtained from reading an old almanac. He then associated with some who studied geometry and took delight in it. About 1790 there was a Mathematical and Philosophical Club at Oldham, and Butterworth, in company with the late Mr. Wolfenden and others, became a member of it. From this society he derived many valuable books, which he read with great avidity, and soon began to answer mathematical questions in public prints. [Cash 1873, 221]

Though he began work spinning at age 6, and only learned to read as a teenager, Butterworth won prizes for answering questions in *The Gentleman's Mathematical Companion*, and he became an active and valued mathematical contributor to *Diary*s, the *Enquirer*, the *Leeds Correspondent*, *The Student*, and the *Mathematical Repository*. Butterworth's mathematical talents helped supplement his meager income: while he found it distasteful, he solved, for a small fee, mathematical problems for others, who would then submit his solutions to mathematical journals under their own names. In the late 1830s, when steam power had made his hand loom all but obsolete, Butterworth began a small school in his home. [Wilkinson 1853a, 56], [Cash 1873, 221–222]

Butterworth passed his practice of communicating geometrical discoveries through question-and-answer journals to another Lancashire weaver, John Kay. Kay, like his mentor, began weaving at a young age, and pursued his studies only in his free time. Butterworth began teaching Kay mathematics around 1800, and by 1808, Kay had made his first contribution to the *Gentleman's Diary*. Like Butterworth, he contributed to the *Enquirer*, the *Leeds Correspondent*, and *The Gentleman's Mathematical Companion*, and gave winning answers to several prize questions. [Wilkinson 1849b]

Kay was able to escape his economic conditions by becoming a local constable and later a cloth manufacturer, but Butterworth and Wolfenden spent the end of their lives in poverty. In 1841, some of the members of the Manchester Literary and Philosophical Society collected money to provide for Wolfenden's later years and to erect a memorial at his grave. [Wilkinson 1849a, 292] The establishment in 1843 in Manchester of the "Society for the Relief and Encouragement of Scientific Men in Humble Life" gives an indication of the extent to which working class men of

Northern England were engaged in science, and specifically, in mathematics. Butterworth received assistance from the Society from 1843 until his death.

The "Lancashire School of Geometers" had a common research focus of classical geometry, which was passed down from teacher to pupil and shared in Society meetings. It also had an outlet for the research products of this common focus, the mathematical questions and answers of journals. For example, John Knowles and Wolfenden's student Hilton attempted to organize the results of his fellow geometers from the North of England in a recurring section of his journal *The Student*. This section, called "Modern Geometry," presented properties about a triangle with inscribed and circumscribed circles.[17] While each proposition and demonstration was crafted by a different contributor, there was one figure[18] to which each contributor referred.[19]

Davies described the "Modern Geometry" section as a "little work of great merit" that had, because of the lack of printed copies, been transcribed "from MS. copies at *third* or *fourth hand*. The inquiries have in several cases been successfully followed up in those different periodicals which are principally devoted to mathematics, but in so unconnected a

17 The first installment of this section declared that "Useful and elegant Geometrical Propositions, whether New or Fugitive, will here meet a welcome reception." [Anonymous 1797, 31]

18 While this figure carried the same labeling over to each successive number of *The Student*, it got more and more complicated. By the fourth and final number of the journal, the figure had labels to 34 points.

19 The diagram described, among other things, triangle ABC and the perpendicular bisector of AB, the diameter HF, which intersects AB at E. Proposition 57 by "W.G." asserted that "If the diameter HF and the difference of the angles at base $CBA - CAB$ be given, then will the ratio of $AC - CB$ to AF be constant, and the same as the ratio of $2CD : CF$." Proposition 59 by a Mr. Walker asserted that "On BH describe a semicircle and produce BC to meet it in x' then will $Cx' = AO$ =half the difference of the sides." Assuming the perpendicular to HF that goes through the center S of the inscribed circle intersects HF at U, Butterworth asserted in Proposition 61 that "The rectangle of the diameter FH and the difference of the segments HU and EU is equal to the square of HS." [Anonymous 1800, 31–32]

form (which is unavoidable in those works) that they are comparatively little known, and their relations are as little perceived." [Davies 1827, 27][20] Wilkinson made a similar lament that "[i]solation and promiscuous arrangement are, indeed, among the characteristics of the Geometry of the Lancashire School." [Wilkinson 1854, 140] While Wilkinson blamed these characteristics on a lack of sensibility to "the value of systematic research" [Wilkinson 1854, 140], the disconnected, sporadic presentation of results by these geometers was certainly encouraged by the format of the publication outlets open to them. The format of mathematical questions and answers in journals that gave these geometers a method of encouragement and communication also dispersed their discoveries over a variety of journals that often appeared only annually.

The Lancashire school was not an isolated phenomenon. Davies described a "Yorkshire School of Geometers" established by John Ryley (1747–1815), editor of the *Leeds Correspondent*. [Davies 1850, 438][21] Appendix A shows that mathematicians from the North of England[22] not only contributed, but also edited many of mathematics journals containing questions and answers.[23]

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20 Davies also noted that the "Modern Geometry" section's organization was "extremely defective; as classes of inquiry very different in many respects are combined in the same series of propositions, and referring to the same diagrams." [Davies 1827, 27] Davies later reflected that "[s]pecial inquiries are prosecuted with great vigour and acumen; but we look in vain for system, classification, or general principles… in truth, it must be confessed to be a vice… almost universal amongst English geometers; and even in the geometry of the Greeks themselves, the great object appears to have been "problem-solving" rather than deduction and arrangement of scientific truths. The modern French geometers have, however, broken this spell." [Davies 1850, 438]

21 Davies pointed out that Lancashire (cotton), Yorkshire (wool), and Spitalfields (silk) were all weaving districts.

22 Here, we define the North of England as those parts of the country lying above the counties of Gloucestershire, Warwickshire, Leicestershire, and Lincolnshire. For a map, see `http://www.sasi.group.shef.ac.uk/maps/nsdivide/index.html` from the Department of Geography at the University of Sheffield.

23 Mathematics was not the only scholarly interest for working class men from the North of England. Anne Secord discusses "artisan" botanists, entomologists, and zoologists form the same area in [Secord 1994].

3.1. *A Northern case study: the Leeds Correspondent*

As Appendix A shows, the mathematical journals edited by the Northern mathematicians had none of the longevity of the *Diaries*. However, even as existing serials were failing, editors and proprietors of new journals enthusiastically entered the publication arena to carry the journalistic torch for mathematics. A network of overlapping support and interest formed between the editors of these periodicals. For example, John Ryley, John Gawthorp (d. 1817), and John Whitley (d. 1855), subsequent editors of the *Leeds Correspondent*, all contributed to the *Enquirer* (1811–1813) of Boston (in Lincolnshire, bordering the North of England) and the *Quarterly Visitor* (1813–1815) of Yorkshire. Not surprisingly, the *Leeds Correspondent* began in 1814 partially based on the models of these two earlier journals. [Wilkinson 1848a, 203]. In fact, the new journal posed some questions left unanswered in the *Enquirer* when it failed after publishing only 11 numbers. [Archibald 1929, 393]. The preface to the first volume described four groups that the *Correspondent* would target:

> In the extensive district of the West Riding of Yorkshire, the vast population of which is generally well-informed, the editors hope to raise many valuable corespondents. Within its boundaries are many Gentlemen, to whom… composition is an agreeable relaxation; — many in humbler life, otherwise the favourites of Heaven in the excellent, yet uncultivated endowments of the mind,… many junior aspirants after learned celebrity, … and many of the fair sex… Of special favours, from these four descriptions of persons, the conductors form great expectations. [Anonymous 1815, vi-vii]

The first editor of the *Leeds Correpondent* came from the second category men from "humble life." Ryley worked in his family's farm and loom until the age of twenty-one, then, as he familiarized himself with mathematics, he was able to become a schoolmaster. He won renown from the editor of the *Ladies Diary*, and, in 1789, he moved into the headmastership at a public school in Leeds. Besides this position, he privately tutored students who planned to go to Cambridge. [Anonymous 1818] Ryley died just before the completion of the first volume of the journal, and the editorial reins passed to John Gawthorp, who died before the third number of the second volume was completed. Despite these deaths, as well as the "misfortune and temporary ruin" of the journal's proprietor, James Nichols, the

Leeds Correspondent continued under the mathematical editorship of John Whitley. [Nichols 1818, iii] Davies considered both Whitley and Gawthorp as members of Ryley's "Yorkshire School of Geometers." [Davies 1850, 438]

The full title of the first volume of the journal, *The Leeds Correspondent, a Literary, Mathematical, and Philosophical Miscellany: Consisting of Original Poetry and Essays; Curious Anecdotes; Themes; Latin and French Extracts for Translation; Philosophical and Grammatical Queries; Mathematical Questions and Answers, &c. &c.*, indicates that its contents were not strictly mathematical. Literary topics in English, French, and Latin, reviews, and biographies occupied the junior and senior departments of the journal. The junior and senior mathematical departments constituted a considerable percentage of pages.[24] Excluding the junior questions, 300 questions were posed and answered in the journal's lifetime. Of these, almost one-third focused on geometry.[25] In a preface to the fourth volume, James Nichols acknowledged that "[s]everal of our Mathematical correspondents complain, that the late numbers have contained a far greater portion of Geometrical than of Algebraical questions and solutions. That Geometry has assumed such a preponderance, is very true; but it is owing greatly to the complainants themselves, who, in their various contributions to the list of New Questions, have neglected to transmit many of those which relate to Algebra." [Nichols 1822]

By the third volume of the *Leeds Correspondent*, an advertisement appeared announcing that "[s]ix numbers of the Leeds Correspondent are now and will be hereafter regularly offered as a prize, to be adjudged BY LOTS to one Gentleman out of those who may give true solutions to the

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24 In volume 1, 14 out of 288 pages (5%) pages were in the junior mathematical department, while 96 out of 288 (33%) were in the senior mathematical department; in volume 2, 23 out of 292 pages(8%) junior, 105 pages (36%) senior; in volume 3, 32 out of 288 pages (11%) junior, 120 pages (42%) senior; for volume 4, 20 out of 328 pages (6%) junior, 69 (21%) senior; for volume 5, 14 out of 252 pages (5%) junior, 46 (18%) senior.

25 Wilkinson typed and counted the questions as Algebra in General (26); Diophantine Analysis (24); Series (6); Chances (10); Geometry, Geometrical Analysis and Construction (87); Application of Algebra to Geometry, Mensuration, &c. (38); Trigonometry, Plane and Spherical (17); Astronomy (7); Fluxions (26); Hydrostatics (3); Loci, Quadrature, Rectification, &c. (22); Statics and Dynamics (34). [Wilkinson 1848a, 303–304].

Prize Question in each number." [Anonymous 1819–1821] The following prize question illustrates the cross-referencing that occurred between mathematical serials:

> If a polygon be inscribed in a Conic Section, so that each of its sides except one may be parallel to a straight line given in position, then that side will either touch a Conic Section similar to the given one, or it will be parallel to a straight line given in position: Required the investigation or demonstration. N.B. The particular case of the triangle was the prize question in No. XVI of the Mathematical Companion for 1813. [Amicus 1822, 4]

The pen name of the writer of this question, Amicus, belonged to John Whitley, who at that time edited the *Leeds Correspondent*. Besides posing questions, Whitley, using the pseudonyms Amicus or "N.Y.," answered four prize questions that had no other competitor. [Wilkinson 1848a, 204].

Outside the mathematical problems department, the *Leeds Correspondent* contained discussions about mathematics. In the "Miscellaneous" section of the journal for 1819, for example, a correspondent reported on a new trend among social gatherings of women:

> [I]t is my happiness to communicate to you the information, that a considerable change has taken place in one of the most genteel female circles in a neighboring town, by adopting philosophical and mathematical amusements in their select parties… The mathematic-mania, all lovely as it is, has infected many an amiable woman. Its tendency, we all know, is to enlarge, ennoble and refine the human intellect; and is it not now generally acknowledged, that women are endowed by Heaven with as large a portion of intelligence as men? [Didascalus 1819–1821]

In the next volume of the journal a bookseller, writing anonymously, recounted the effect of the earlier "Female Mathematicians" article on his family. He complained that soon after reading this article, the women in his neighborhood

> … became tolerably expert mathematicians and newly fledged philosophers and (O unhappy me!) my wife among the rest. It is not much out of character, or injurious to any other person, for a Newton to forget his dinner in the labyrinthine sinuosities of philosophical research… But nothing can be more prodigiously anomalous and unnatural, than for the wife of a tradesman to be puzzling her brains with the solution of a difficult problem when the dinner should be smoking hot on the parlour table, and her family partaking of it… [T]he study of Mathematics, as they are and ought to be studied, is

> incompatible with the matronly duties of a good housewife. Why … should the ladies be suffered to encroach on our studies, or to intermeddle with masculine concerns? [Bipliopola 1822]

With a readership that the extracts above indicate must have included women as well as men, the *Leeds Correspondent* seemed to be in a period of expansion by its fourth volume. Nichols announced in 1822 "that the change from a half-yearly to a Quarterly mode of publication has afforded much satisfaction to several of the purchasers and contributors… At the close of the next Volume, it is not improbable, the suggestion of some friends may be adopted, in reference to a New Series printed in OCTAVO." [Nichols 1822] The next volume, however, ended prematurely with only three numbers. The *Leeds Correspondent*, which had begun its mathematical question department with the remains of the fallen *Enquirer*, surrendered its last questions to the *Scientific Receptacle*. This new journal began in 1825 and was edited by the Lincolnshire mathematics teacher, Henry Clay, who hoped to "elicit the latent spark of genius, to create a generous and laudable emulation among the youthful votaries of science, to disseminate useful and entertaining knowledge, and to open a field for the recreation and exertion of the adept in mathematics."[26] Despite these lofty goals, the *Receptacle* expired after only four numbers.

A commercial mathematical journal was constantly in danger of economic demise. While the example of the *Leeds Correspondent* illustrates the delicate relationship between publishing mathematics and establishing a sound business venture, journal proprietors repeatedly agreed to include mathematics among their pages.

4. BRITISH MILITARY INSTITUTIONS: A CENTER FOR A GENRE

British military institutions provided another center for question-and-answer journals. Until the middle of the nineteenth century, the mathematicians for these institutions were by and large hired from the ranks of self-taught philomaths and not from those of the university sphere. For example, Thomas Simpson was appointed the second professor of

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26 *The Scientific Receptacle*, quoted in [Wilkinson 1848a].

mathematics, only two years after the Military Academy at Woolwich was established in 1741 (it was established as the Royal Military Academy (RMA) in 1764). [Johnson 1989b, 156–157, 162] The self-taught son of a Leicestershire weaver, Simpson moved in 1736 to Spitalfields in London, where supported himself as both a weaver and a mathematics teacher (specifically, he tutored mathematics through the Spitalfields Mathematical Society). From this time, he contributed mathematics to the *Ladies Diary* and the *Gentleman's Magazine*. [Guicciardini 2004b] Simpson owed his appointment to the Military Academy to the recommendation of Martin Folkes (1690–1754), first chief master of the Military Academy and President of the Royal Society of London. Two years into his appointment, Simpson began co-editing the *Mathematician*, and in 1754, he succeeded Robert Heath as editor of the *Ladies Diary*. Simpson left this editorship in 1760, and was replaced by one of his *Mathematician* co-editors, Edward Rollinson (1718–1773). From Rollinson, the editorship returned to the RMA, where it would remain until 1840.

Charles Hutton (1737–1823), who succeeded Rollinson as editor, had a similar background to Simpson. While an injury to his elbow allowed him to study at school instead of working in the mines, Hutton did for a time support himself as a coal cutter until he was able to find a post as a mathematics teacher. [Guicciardini 2004a] Hutton began contributing to the *Ladies' Diary* in 1764. [Guicciardini 1989, 115] In 1773, he faced nine competitors (all mathematical practitioners) in the first public examination for the RMA professorship of mathematics. [Wardhaugh 2012a, 189] This examination might have been established to ascertain the qualifications of candidates whose training was outside of the university sphere. Included in this multi-day examination was solving problems from a variety of mathematical areas. [Johnson 1989a, 202–203] Hutton, who had been solving problems for almost ten years in mathematical journals, won the competition for professor and began editing the *Ladies Diary* in the same year. As editor, "he encouraged many younger mathematicians and acted as a leader of the philomathic movement." [Wallis et al. 1991, 13] For example, Hutton encouraged *Ladies Diary* contributor, Peter Barlow (1776–1862), to vie for an assistant mathematical master position at the RMA. Although he faced a "severe competitive examination," Barlow, previously a tradesman

and schoolmaster, prevailed; in fact, he was later promoted to Professor. [Morus & Clerke 2005]

Olinthus Gregory (1774–1841), whose religious convictions ruled out for him a university (and, specifically, Cambridge) education,[27] became a *Ladies' Diary* contributor beginning in 1794, and was deeply influenced by Hutton. With the editor's help, Gregory became second mathematical assistant at Woolwich in 1802;[28] in the same year, he began editing the *Gentleman's Diary*. In 1818, Hutton, already in his tenth year of retirement from Woolwich, passed the editorship of the *Ladies' Diary*, as well as the superintendence of all of the Stationer's Company almanacs and their requisite astronomical calculations, to Gregory. In his role as editor, Gregory was described as giving "protection and encouragement … to those who were pursuing the path which he himself had trodden." [Anonymous 1841, 81] In 1820, Gregory continued the dynasty of military college editors by passing the *Gentleman's Diary* to Thomas Leybourn, mathematical master at the Royal Military College (RMC) in Marlow (later Sandhurst).

By the time he took the mantle of the *Gentleman's Diary*, Leybourn was already a veteran of mathematical periodicals. Yet another self-taught mathematician from the North of England, he became one of Hutton's contributors to the *Ladies Diary* in the early 1790s. [Anonymous 1841, 83] He established the *Mathematical and Philosophical Repository* in 1795. Like the *Diaries*, this journal was composed of problems-for-answer whose utility, Leybourn described,"will be readily admitted when it is considered, that almost all the improvements which the mathematics have received, have originated in the exertions made to resolve particular problems." In addition, the *Repository* also included original papers, translations, and abstracts "least likely to fall into the hands of general readers." [Leybourn 1806] Seven years into this venture, Leybourn was appointed, on Hutton's recommendation, at the RMC; [Anonymous 1841, 83] he was soon joined there by one of the contributors to his *Repository*, William Wallace. Born in Scotland, Wallace was self-educated and worked first as a bookbinder

27 Until 1856, Cambridge students were required to pass religious tests of the Anglican church before they could receive a degree.

28 Like Barlow, Gregory subsequently progressed to the position of professor at the RMA (in 1821).

but later became a teacher. In 1803, he was informed of an opening at the RMC by an anonymous letter; later in life, he claimed that this opportune letter was thanks to recognition he received in question-and-answer journals. [Anonymous 1844, 35] Besides the frequent articles by Wallace and fellow RMC mathematical master James Ivory (1765–1842), Gregory and his colleague Barlow at Woolwich were also major contributors to the *Mathematical Repository*.[29] The English military colleges formed the focus for this journal; in fact, contributors outside of these military colleges accounted for only about about one-fourth of the solutions to questions and a few essays. [Guicciardini 1989, 116–117] In his work on the development of calculus in Britain, Niccolò Guicciardini assessed the first three volumes in the new series of Leybourn's *Repository* as "one of the most important works in the reform of the British calculus." [Guicciardini 1989, 116][30]

The mathematical significance and the longevity (40 years) of Leybourn's *Repository* did not indicate its commercial success; in fact, it was "attended with a considerable pecuniary sacrifice," and only the "liberality he shewed [*sic*] in defraying the expense" kept the enterprise going. [Anonymous 1844, 83]

As editor of the *Gentleman's Diary*, Leybourn tried to increase its scientific contents, and he eliminated the journal's charades and enigmas in 1834.

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29 T. S. Davies asserted that Leybourn also received extensive editorial help from a group of friends including Ivory, Wallace, Hutton, Gregory, John Lowry (1769–1850), who also taught mathematics at the RMC, and himself. [Davies 1851, 446]

30 While calculus reform was a focus in the *Mathematical Repository*, its presence was not a given in other mathematical journals of the period. Wilkinson noted in his 1848 evaluation of the *Leeds Correspondent* that "it is evident that the efforts of Woodhouse, Peacock, Herschel, and Babbage to introduce a taste for analytics, however successful they might be at the universities and public schools, were unavailing so far as regarded most of the non-academical correspondents of the mathematical periodicals." [Wilkinson 1848a, 303–304] For more on these Cambridge mathematicians' efforts to popularize what Wilkinson called "analytics," that is, the Continental approach to the calculus, see below in section 6. In their 2009 investigation of the *Ladies Diary*, Albree and Brown noted that no notice of Cambridge calculus reform appeared in the *Ladies Diary* during the first third of the nineteenth century. [Albree & Brown 2009, 30] However, they did notice a more gradual, organic infiltration of the new methods into the *Diary*. By the 1820s, some questions were answered using both fluxions and fluents and derivative and integrals; gradually, the new system attracted the interest of some *Diary* contributors. [Albree & Brown 2009, 27–28]

Wilkinson, in his 1848 review of mathematical periodicals, reported that two years later "he was again induced to readmit a portion of these 'ingenious puzzles.' " However, thanks to the abolition of the Stamp Tax, Leybourn was able to add mathematical appendices containing original mathematical articles beginning in 1835. [Wilkinson 1848b, 57] In the same year, Gregory had also added mathematical appendices to the *Ladies Diary*.[31] The year 1840 marked the end of both men's editorships of the *Diary*s: the February 1841 report of the Royal Astronomical Society contained back-to-back obituaries of the two men. [Anonymous 1841] That same year, the journals merged to form the *Lady's and Gentleman's Diary*, and the editorship passed to Wesley Stoker Barker Woolhouse (1809– 1893).

The son of a greengrocer from the North of England, Woolhouse had won a prize from the *Ladies Diary* by the age of thirteen. [Anonymous 1894, 204] Although he was not employed at the RMA or the RMC, he was one of Gregory's protégés, and he served as deputy superintendent of the *Nautical Almanac*.[32] Wilkinson gave a contemporary assessment of Woolhouse's performance as editor:

> Although one of our ablest living mathematicians, he is nevertheless mostly *self-taught*; he knows what it is to climb the hill of science without trained assistance, and hence he is ever ready to encourage those who have not had the advantages of a University education. The questions are therefore selected so as to meet the views of both classes of students; and the labours of the hard-working artisan are consequently not infrequently found in close companionship with those of the graduates of our Universities. [Wilkinson 1864, 83]

Woolhouse continued the *Lady's and Gentleman's* until 1871, marking the end to a *Diary* tradition that lasted over 165 years.

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31 For an analysis of the *Ladies Diary* appendices, see [Albree & Brown 2009, 31]. The end of the Stamp Tax on almanacs meant that most prices for almanacs dropped by half and thus sales for the Stationers' Company increased to 600,000 almanacs by 1837. However, the absence of this tax meant that rival almanacs independent of the Stationers' Company "could now compete with the Company on equal terms, and the result was a long decline for its almanacs." [Wardhaugh 2012a, 234]

32 The *Nautical Almanac* was a nationally-funded venture begun by Astronomer Royal Nevil Maskelyne (1732–1811) in 1765. It contained tables of lunar distances that enabled navigators to calculate longitude without a chronometer, a costly instrument that could be damaged by the elements. Hutton had worked as a "comparer" (one who checked calculations) for the *Nautical Almanac*. [Wardhaugh 2012a, 170–175]

In his study of Royal Society President Sir Humphry Davy (1778–1829), D.P. Miller characterized the challenges faced and the opportunities created by philomaths (or, as Miller categorized them, mathematical practitioners) such as Simpson, Hutton, Gregory, Leybourn, and Woolhouse:

> Their social status and often dissenting religious persuasions hindered their full participation in the higher cultural circles of metropolitan life. Hence, an alternative intellectual world was constructed which centred on London's private academies and mathematical schools, the tradition of practical mathematics maintained at the Royal Military Academy and the Royal Military College, and almanacs published under the auspices of the Stationers' Company. [Miller 1983, 10]

An appointment at a military institution might have helped a philomath to gain access one "higher cultural circle," the Royal Society of London; however, once there, his status there was uncertain. Simpson was elected Fellow of the Royal Society two years after joining the Woolwich faculty. [Guicciardini 2004b] Hutton was elected F.R.S. just one year after his own Woolwich appointment, won the Copley Medal of the Society in 1778, and assumed the Foreign Secretary position in the Society in 1779. However, Hutton resigned his fellowship in 1784 after being pushed out of the foreign secretaryship by Royal Society president, Sir Joseph Banks. Several other philomaths left the Society in protest, and "the dissensions of 1784 long continued to shape the attitudes of the Practitioners and the Royal Society elite towards each other." [Miller 1983, 10] Gregory, remembering Banks' mistreatment of his mentor, published an anonymous account of Banks' wrongdoings in the *Philosophical Magazine* in 1820. He was thus aligned with others who sought reform at the Royal Society such as John Herschel (1792–1871) and Charles Babbage (1791–1871) ; all three of these men helped found in 1820 the Astronomical Society of London (later, the Royal Astronomical Society). [Miller 1983, 11–12] This group also sparked reforms of the *Nautical Almanac* targeted at widening it usefulness beyond navigation. Woolhouse began his tenure at the *Almanac* when it was in the midst of reforms.[33] [Miller 1983, 18]

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33 Gregory had also railed in print against what he saw as the Society's bad judgment in selecting papers for publication; central to the Royal Society reforms of the 1830s

While the Royal Society of London had a contentious history with the philomaths of the RMC and RMA, the Royal Astronomical Society gave them a place to interact with mathematicians outside of the military institutions; in fact, in her study of the *Educational Times*, Janet Delve suggests that "[i]t is possible that society meetings provided an informal forum for them to discuss mathematical problems posed in the current journals." [Delve [Burt] 1998, 260]

4.1. *A military case study: the* Mathematician

Three such Royal Astronomical Society members and mathematical masters at the RMA, Thomas Stephens Davies (1794/5–1851), William Rutherford (1797/8–1871), and Stephen Fenwick launched the *Mathematician* in 1843 as an attempt to fill a void left by the cessation of Leybourn's *Mathematical Repository*. The Woolwich team, all from the north of England, recognized the difficulties experienced by previous mathematical journals, writing that "[i]n a commercial point of view, such undertakings as the present have invariably been attended with considerable loss, and we have no reason to anticipate that in the present case the result would, under ordinary circumstances, be materially different." To handle these inevitable financial hardships, the editors and their friends formed "a society, for raising a small annual fund to meet that part of the expenses of the publication, which would not be covered by the returns from its sale." [Davies et al. 1843a, 3]

The editors also took an innovative approach to the traditional question-and-answer department:

> It is our intention to curtail, in some degree, the department of mathematical questions; for though we are fully impressed with a sense of the importance of this feature of the work, universal experience shows the difficulty of forming a sufficient number of new and good questions, where a fixed number must be made up by a given time; and the insertion of such as lead to mere petty details of calculation and deduction, suited only for the student's private exercise, tends not only to lead him into frivolous researches, but to create a false taste in science. We shall, hence, insert only such as involve some new principle, or require for their solution some new modes of investigation… [W]e hope to render this

was the establishment of formal referee's reports for submitted papers. See [Miller 1983, 11–12] and [Despeaux 2011b].

> department free from the reproach so often applied to works of this class – that of "creating a race of mere problem-solvers." [Davies et al. 1843a, 2]

The editors received over 550 printable answers to the proposed questions.[34] These solutions were submitted by approximately 83 contributors.[35] However, 300 of these solutions came from only nine contributors. The top two producers of solutions, Thomas Weddle (1817–1853) and George Hearn (1812–1851), both taught at the RMC in Sandhurst and provided over one-fourth of these solutions.[36]

At least 73 contributors either proposed the journal's 189 questions, submitted papers in the journal's departments of Algebra (21 papers), Calculus and Differential Equations (8), Mechanics (6), Miscellaneous (23), Plane and Spherical Trigonometry (11), Plane Geometry (45), Probability (2), or Solid Geometry(19), or provided several small mathematical notes. Fenwick, Rutherford, and Davies (using his real name as well as his pseudonym, Pen-and-Ink) were among the top eight contributors of problems or papers; this group submitted almost half of the items. Hearn and Weddle also belonged to this group and represent the two most active contributors to the *Mathematician*; they provided over one-fifth of the journal's contributions. A little over 100 people provided all of the material for this periodical over its eight-year existence.

The editors of the *Mathematician* clearly felt the need to fill a void in the mathematics publication sphere. In the preface to the journal's first volume, they cited the *Lady's and Gentleman's Diary* as "The only work published in this country in which a regular portion of space is allowed

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34 Fewer than 550 solutions were published because if more than one contributor submitted similar solutions, only one solution was printed, and all the names of the contributors were listed.

35 Several contributors wrote anonymously. Thus, the number of contributors should be considered an estimate.

36 Hearn, from Northumberland in the north of England, graduated from Cambridge as Sixth Wrangler in 1839, then immediately assumed a professorship at the RMC, where he stayed until his untimely death in 1851. [Venn 1922–1954] Weddle, similarly short lived, followed a familiar track for the military institutions, and he progressed to his Sandhurst Professorship after teaching in the north of England and around London. [Crilly 2004, 488] Besides the *Mathematician*, Weddle was an active contributor to the *Ladies' Diary*, the *Northumbrian Mirror*, and the *Cambridge and Dublin Mathematical Journal*.

to… [mathematical] researches, and which is at the same time open to all correspondents." [Davies et al. 1843a, 1] The fact that the editors did not mention the *Cambridge Mathematical Journal* (*CMJ*),[37] which had been in existence for six years at the time this preface was written, indicates that they felt the journal was too exclusive. In fact, Steven Fenwick experienced this exclusivity firsthand when he submitted an article to the *CMJ*'s successor, the *Cambridge and Dublin Mathematical Journal* (*CMDJ*). Arthur Cayley (1821–1895), acting as a volunteer referee to editor William Thomson (later Lord Kelvin) (1824–1907), wrote to the editor that "I do not think you ought to print Fenwick's paper; almost all, if not the whole of it is known… besides treating the subject in that way without any reference to general geometrical theories or without any attempt to make a 'Zusammen Gesetzung' of the whole mass of theorems one obtains, is very uninteresting work." [Cayley, 1847] Fenwick ultimately never appeared in the *CMDJ*.[38] Davies, on the other hand, was recruited to write article for the *CDMJ*. [Crilly 2004, 460]

Although the *Mathematician* enjoyed support from a devoted band of contributors and was even reprinted in part in Germany,[39] the journal ceased to be printed after the first three volumes. Rutherford and Fenwick, who had edited the last two volumes without Davies, reported to their readers that they had hoped the journal could be continued "under other auspices," but "[t]hat hope has not been realized; and… [we] now issue the supplementary number… without being able to hold out the least hope of the blank, which is thus created in our mathematical literature, being filled up." The editors had made great efforts to continue the enterprise, and had even corrected the proof sheets themselves to save money. "This labour," they explained, "became so continuous, that is occupied almost the whole of… [our] disposable time. This explanation will, the Editors trust, be satisfactory, both as a reason for the discontinuance of

37 For more on the *CMJ* and its successors, see [Crilly 2004].

38 For more on this incident, see [Crilly 2004, 481]. For Thomas Weddle's relationship with the *CDMJ* see [Despeaux 2002, 170–172].

39 Reprints of portions of the *Mathematician* were made by August Wiegand in Germany. [Fenwick 1850]

the work, and for any oversights that may be detected in any part of it." [Fenwick 1850]

This case study exemplifies the commitment that the mathematics faculty at the RMC and RMA had for keeping the question-and-answer mathematical genre alive. Many of these men achieved the first notice of their mathematical prowess not through winning honors at university but rather by winning prize problems. Their participation in the question-and-answer journals set them on a path leading to a military college career that, for many of them, was worlds away from their "humble" origins. As active contributors and tireless editors, they were fully engaged in this forum for mathematics.

5. CONTEMPORARY EVALUATIONS OF THE QUESTION-AND-ANSWER GENRE

How was this forum regarded by contemporaries? A sample of commentaries from periodical press of the time can give an indication of the range of opinions. Many of these contemporary editorials compare the mathematical motivation provided by question-and-answer journals to that provided by Oxford and Cambridge.

In his 1808 review of Laplace's *Traité de Mécanique Céleste*, University of Edinburgh Professor John Playfair (1748–1819) described the periodicals that comprised the question-and-answer tradition:

> In these, many curious problems, not of the highest order indeed, but still having a considerable degree of difficulty, and far beyond the mere elements of science, are often to be met with; and the great number of ingenious men who take a share in proposing and answering these questions, whom one has never heard of any where else, is not a little surprising. Nothing of the same kind, we believe, is to be found in any other country. [Playfair 1808, 282]

These serials, in Playfair's opinion, provided proof that "a certain degree of mathematical science, and indeed no inconsiderable degree, is perhaps more widely diffused in England, than in any other country of the world." While he classified the non-mathematical parts of the *Ladies Diary* as "in the worst taste possible," Playfair found that "[t]he geometrical part, however, has always been conducted in a superior style; the problems proposed

have tended to awaken curiosity, and the solutions to convey instruction, in a much better manner than is always to be found in more splendid publications." [Playfair 1808, 279, 282] In contrast to these positive assessments, Playfair lamented the state of mathematical instruction in the universities, especially Cambridge. To gain mathematical honors there, a student had to learn mathematics "as a child does his chatechism [*sic.*], by heart, so as to answer readily to certain interrogations. In all this, the invention finds no exercise; the student is confined within narrow limits; his curiosity is not roused; the spirit of discovery is not awakened." [40] [Playfair 1808, 283]

A negative evaluation of the *Diaries* and the *Mathematical Repository* incited a heated exchanged published in 1819 in the commercial scientific periodicals, the *Annals of Philosophy* and the *Philosophical Magazine*.

Engineer Henry Meikle held that

> Periodical mathematical works … are mostly made up of mere puzzling questions, totally useless and unconnected with science. Persons who torment themselves with such nonsense, might as well be assisting Sisyphus in rolling his stone, for any good they are doing either themselves or others, except it be to keep them out of mischief. But even this laudable end might be attained in solving questions serving some more useful purpose. [Meikle 1819, 292]

In response to Meikle's deprecation of mathematical journals, a correspondent with the pseudonym "Mathematicus" rebutted that:

> [T]he mathematical sciences in this country owe the most solid obligations to those periodical publications. He [Meikle] would know, that while the managers of some learned societies have for many years laboured hard to stifle mathematical knowledge, those publications, by presenting a strong and varied stimulus to young investigators, have done as much if not more than even Cambridge and Oxford to keep it alive: – he would know that some of the able philosophers from France, Germany, Denmark, and other countries, who have recently visited England, have so highly appreciated the value of *three* of those publications, viz. The Ladies' Diary, The Gentleman's Diary, and Leybourn's Mathematical Repository, as to take back with them complete series of each, that they might introduce into their own respective countries works formed upon the models of ours; or, as Mr. M. would say, might 'torment *them* with such nonsense.'… Mr. Meikle affirms that those periodical publications are 'mostly made up of *mere puzzling questions, totally useless and unconnected with science.*'…

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40 Playfair acted as patron to RMC faculty member and active problem-and-answer contributor, William Wallace, discussed above. [Panteki & Stronach 2004]

> This gentleman should… recollect that an inquiry which, at first sight, appears merely speculative, may ultimately be found of practical utility. [Mathematicus 1819, 368–369]

Thomas Kirkman (1806–1895), a country rector and active mathematical author, extolled similar virtues of the *Ladies' Diary* over 40 years later: "an incomparably greater share of the glory of kindling and cherishing a pure and lasting love of mathematical science in men as well as boys, must be attributed to the immortal *Lady Dia*[ry], than to all the universities and colleges of these kingdoms put together, to all our Lyceums, Athenæums, and Philosophical Societies, and to all our Imperial Boards of peace and war." [41]

Morgan Brierley (1824–1897), in his 1877 article on Lancashire mathematicians, described the mathematical journals up to 1850 as "at once the nurseries and repositories of the highest mathematical studies of the time." Moreover, "[t]he greatest scientific men of the last century and the beginning of this, first tried their 'prentice hand' in it, and many of them stuck to it to the end of their lives. It is full of the richest elements of mathematical truth, and there is not a standard work on Mathematics, either in the universities or public schools of to-day, that is not more or less indebted [to it] for principles, examples, and illustrations." [42] [Brierley 1878, 7]
While the almost religious fervor of "Mathematicus," Kirkman, and Brierley in their appraisal of these journals can not give an accurate picture of what the average person thought of these journals, it does convey the strong sense of self-identification and pride these men felt with the genre.

Instead of unfavorably comparing the mathematical training received at universities to that gained by participating in mathematical journals, as did

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41 Thomas Penyngton Kirkman, 1850, quoted in [Brierley 1878, 10]. A prize question from the 1844 *Lady's and Gentleman's Diary* inspired Kirkman to begin research in combinatorics. He is best known for his "fifteen schoolgirls problem," that he posed in the 1850 edition of the *Diary*. Arthur Cayley was the first to propose a solution, which he published in the *Philosophical Magazine*. [Biggs 1981, 98–100]

42 Brierley was from the North of England, sent to work in the mill at age 6, and, as a young man, he was part of the meetings held by Wolfenden and Butterworth. He contributed to both *Diaries* and the *York Courant*. He was involved in the family flannel manufacturing business, held a free night school, and became a member of the Manchester Literary Club. [Brierly 1900, 1–60]

most of the above assessments, an 1844 correspondent to the *Philosophical Magazine* pointed out what he saw as a positive motivational tool common to both. Writing under the pseudonym "J.J.," the correspondent wrote that at Cambridge in particular:

> Solving questions at college examinations leads to distinction and college emoluments, so that the studious and talented undergraduate is in a continual round of problem-solving… In my opinion it is this continuance of solving problems, this general course of not only acquiring principles but applying them, that at last makes the senior wrangler, who perhaps at the time is one of the most expert mathematicians in existence… Unless my view of the system pursued at Cambridge, &c. be altogether erroneous, mathematicians are there made, not by merely *reading* and *studying* mathematical works, but by applying their readings, and by the encouragements held out at examinations to the most successful competitors. [J. 1844, 83–84]

The "non-academic" student could find a similar spirit of competition in the prize problems of question-and-answer journals:

> Prizes were proposed as inducements. Students of all grades of attainment had not only an opportunity of making known their acquirements in a manner most gratifying to themselves, but the prizes given in these highly useful publications had in some measure the same encouraging effect upon non-academic students as college prizes, &c. have upon students of a higher order. [J. 1844, 85]

"J.J."'s identification of the similar competitive spirit found in college examinations and in the questions and answers published in journals is apt and helps explain why the this genre continued in Britain into the twentieth century, long after the age of the philomath had passed.

6. THE "PROBLEM AGE": EXAMINATIONS AS CULTIVATORS OF TASTE FOR QUESTION-AND-ANSWER JOURNALS

The Senate House, or Tripos[43], examination was well established in Cambridge by 1735, and it soon superseded the earlier practice of disputations for determining the rank of graduating students. [Gascoigne

[43] The name "Tripos" was derived from the three-legged seats on which university representatives sat during oral examinations of degree candidates in the fifteenth century. [Ball 1889, 217].

1984, 549–550] The content of the examinations became increasingly mathematical, and competition for the highest honor bracket, the wranglers, increased the difficulty of the mathematics: "[a]lthough a very little knowledge might suffice for passing in the early nineteenth century, there was no maximum for the competition to be a wrangler." [Enros 1981, 139].

As a high-ranking wrangler, a graduate gained access to promising positions in the university, church, and government. Until 1850, the examinations were a required hurdle for all Cambridge students seeking a bachelor of arts degree and not just for those seeking honors and positions. [Ball 1889, 212] For example, even after a classical examination was created in 1824, its candidates were limited only to those who had sat successfully for the Senate House Examination. [Glaisher 1886, 15–16][44]

In the last third of the eighteenth century, rising student enrollment and pressure to more precisely rank students in an impartial manner resulted in the introduction of written questions to the examination. By 1830, the oral part of the Tripos examination was discontinued entirely. [Warwick 2003, 118, 122, 131] Before the introduction of written examination problems,

> mathematical education, like other branches of study institutionalized at the medieval university, was based mainly on private reading, oral debate, and catechetical lectures. The introduction of paper-based mathematical study gradually displaced these long-established pedagogical traditions, instituting instead tough regimes of competitive technical training. [Warwick 2003, 116]

The Senate House Examination encouraged a competitive, problem-based way to study mathematics at Cambridge. As a result, its contents also tightly circumscribed the mathematical subject areas that students were motivated to study. Students prepared by working through the problems of previous examinations, so "the growing archive of questions both defined an effective syllabus of mathematical studies and provided exercises through which students could hone their problem-solving skills." [Warwick 2003, 144] This "effective syllabus" could be changed by Tripos

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44 By 1824, the two examinations became known as the Mathematical Tripos and the Classical Tripos; the Moral Science and Natural Science Triposes were first held in 1851.

moderators, who had often been high wranglers just a few years before.[45] For example, the integration of Continental mathematical methods into Cambridge was encouraged when two examination moderators, George Peacock (1791–1858) and Richard Gwatkin (1791–1870), former members of the Analytical Society, set calculus questions using *d*-notation. [Warwick 2003, 68][46]

While the previous Senate House questions were available to students studying for the examination, their answers were not, so students began to seek the help of private tutors. [Warwick 2003, 144] Because not every student could afford such tutors, Cambridge graduate and mathematics teacher J.M.F. Wright began publishing in 1830 *The Private Tutor*. This weekly journal appeared for two years, and it contained mathematical essays as well as details on the examination proceedings. Moreover, each week, the journal posed problems for the student to solve and printed the solutions in the next issue. [Warwick 2003, 82] Five years later, the *Cambridge Mathematical Journal* included discussions of Senate House Examination problems. [Anonymous 1837–1839], [Anonymous 1839–1841], [Anonymous 1841–1843] However, these discussions ended after the *Journal*'s third number in 1843. By this time, past Tripos problems and their solutions were beginning to appear in Cambridge textbooks; by mid-century, volumes of Tripos problems and solutions were produced. [Warwick 2003, 167]

Competition was at the heart of the Tripos.[47] Andrew Warwick, in his study of mathematical physics at Cambridge, writes that "[o]nly in the early Victorian period did the competitive study of mathematics become a hallmark of cerebral manliness." [Warwick 2003, 223] Leslie Stephen (1832–1904), twentieth wrangler for the 1850 Tripos, made the following colorful analogy that emphasized the competitive nature of the examination:

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45 Moderators were charged with writing and grading the examination.

46 For more on the Analytical Society and its efforts, see [Becher 1980] and [Enros 1981].

47 While we have here emphasized the Mathematical Tripos Examination at Cambridge, students there also sat for college examinations, Smith's Prize examinations, and fellowship examinations. For more about the Tripos and Smith's Prize examinations, see [Craik 2007, 90–98] and [Barrow-Green 1999].

> People sometimes ask, What is the good of horse-racing? The respectable and ostensible reply is that it improves the breed of horses. Our educational system is supposed to improve the breed of undergraduates, and in very much the same way… The examination is to the undergraduate what the race-course is to the inferior animal… The senior wrangler is the winner of the Derby. [Stephen 1932, 24–25]

Cambridge was not alone in establishing university examinations. Oxford developed its examinations around 1800, [Roach 1971, 13] and by 1830 at Trinity College Dublin, mathematics and theoretical physics had gained "complete ascendency" in the existing fellowship examination. [McDowell & Webb 1982, 128] By mid-century, this examination model began to be applied beyond the university sphere. The College of Preceptors, initially founded in 1846 to certify teachers, began external examinations for secondary school students in 1850. [Delve 2003] Oxford and Cambridge separately launched their own secondary school examination programs in 1858. In the mid-1860s, Cambridge established scholarship examinations that enabled students from the lower middle class to afford to attend the University. [Warwick 2003, 256] Beyond the secondary schools, in 1853, a competitive examination became required for the Indian Civil Service; soon after, similar examinations for the military academies were established. [Howson 1982, 160–161] The rapid proliferation of the examination model reflected a "belief, in academic and public life that open competitive examinations would remove favoritism, reward hard work, encourage good sportsmanship, discourage patronage, and offer improved avenues to upwards mobility." [MacLeod 1982, 3]

Mathematics formed a key component of these examinations. For example, mathematics occupied a prominent place in the College of Preceptors general examination for teachers; it had separate mathematics examinations as well.[48] As a result of the emphasis on mathematics in examinations, the status of mathematics in the secondary school curriculum was greatly improved. Cambridge wranglers were recruited by leading schools

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48 The first mathematical examiners for the College were George Boole (1815–1864) and Cambridge graduates John Hind (1796–1866) (2nd wrangler and 2nd Smith's Prizeman) and James Wharton (d. 1862). Subsequent examiners included James Joseph Sylvester (1814–1897) and T.S. Davies. [Delve 2003, 151]

to become mathematics teachers, and they imported the problem-based approach to mathematics that they themselves had been taught. In this way, school examinations provided the catalyst for the "establishment of a wrangler culture of mathematical training in several leading schools." [Warwick 2003, 256]

While they disseminated problem-solving techniques to their students, these wrangler-schoolmasters also continued to pose and solve new problems of their own. Mathematics journals containing questions and answers provided an outlet for those who as students were trained for competition in the problem-solving arena of examinations. On the pages of these journals, the mathematical practice of solving problems in a competitive examination environment coincided with the earlier, avocational problem-solving tradition of the philomaths. Moreover, the newer practice eventually sustained the problem-and-solution genre as the number of self-taught mathematicians waned.[49]

6.1. *A "Problem Age" case study: The* Educational Times

The *Educational Times* (*ET*) began in 1847 as the unofficial journal of the College of Preceptors, one of the leaders in the examination movement in Britain.[50] In accordance with the College's goals, the *ET* focused on pedagogical themes, including methods for teaching mathematics, and past questions and sample answers from Preceptors' examinations. Reviews of mathematical textbooks appeared as well as articles on mathematics education by Augustus De Morgan (1806–1871) and two members of the College of Preceptors, Richard Wilson (1798–1879) and James Wharton (d.1862). [Delve [Burt] 1998, 106] Mathematical questions soon infiltrated the monthly journal, and, by 1849, the department of "Mathematics Questions and Solutions" was established. Under the editorships

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49 Nineteenth-century Britain was subject to several waves of educational reform, and by 1891, free elementary education was made available to any student. For more on these reforms, see [Delve 2003, 142–145].

50 In 1861, the journal finally carried the subtitle of "journal of the College of Preceptors." It was initially priced at 6d "thus putting it at the cheaper end of the range of contemporary mathematical journals." [Delve 2003, 148–150]

of Cambridge graduates Wilson (15th Wrangler) and Wharton,[51] the department developed the objective "to introduce amongst teachers sound methods of mathematical demonstration, [rather] than to lead a few to display the powers of their extraordinary mathematical genius." [52] A section for junior mathematical questions that ran from 1851 to 1854 extended the editors' intended audience to students as well as teachers. From its beginnings to 1862, the editors of the mathematical department "wanted it to contain solutions demonstrating sound mathematical method to aid students and teachers alike. Sometimes several different methods of solution were given for a single question, in order to demonstrate their different methods." [Delve [Burt] 1998, 141]

The subjects covered in the early years of the mathematical department were dominated by geometry and those topics treated in the British institutions of higher education. [Delve [Burt] 1998, 303–304][53] The emphasis in geometry can be partly explained by the involvement of several Northern geometers in the early years of the journal. T. T. Wilkinson, in particular, was an extremely active contributor to the *ET*. In addition to posing 81 problems and solving 110 from 1849 to 1861, Wilkinson also submitted 19 geometrical problems, and their solutions, of the Northern geometer J.H Swale (d. 1831). [Delve [Burt] 1998, 232, 235] Swale had edited the short-lived *Liverpool Apollonius*; from December 1850 to October 1851, extracts of then hard to find *Liverpool Apollonius* occupied a significant amount of space in the *ET* mathematical department. [Delve [Burt] 1998, 123] Henry

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51 Although the editors were never named in the *Educational Times*, through evidence from the journal itself and secondary sources, Delve has convincingly argued that Wilson and Wharton were the first directors of this department. [Delve [Burt] 1998, 131]

52 *Educational Times* (August 1850): 254; quoted in [Delve [Burt] 1998, 116].

53 Delve finds that for the 1268 questions posed from 1847 through 1862, 18% of the questions concerned Euclidean rectilinear geometry while 10% covered Euclidean circular geometry. Besides geometry, the main subject areas were "solving equations, conic sections, plane trigonometry, analytic geometry and dynamics." [Delve [Burt] 1998, 315].

Buckley (c. 1807– c. 1856), a pupil of the Northern geometer John Butterworth, used the pseudonym "Theon" to pose and fund the first prize question to the *ET* in October 1851. [Delve [Burt] 1998, 120][54] Two years after his own mathematical journal, the *Mathematician*, had folded, Northern geometer and RMA mathematical master William Rutherford submitted the first of 51 solutions to *ET* problems. [Delve [Burt] 1998, 232,236] By this time, only the *Lady's and Gentleman's Diary* remained from the earlier question-and-answer mathematical journals; bereft of outlets for the publication of their problem-based mathematics, these geometers embraced and shaped the *ET*.

Besides the self-taught mathematicians, products of Cambridge and its Tripos examination also began to contribute to the *ET*. Rev. Thomas Gaskin (1809–1887), second wrangler and second Smith's Prizeman for 1831, made posed 3 problems to the *ET* and solved 11 in the mid-1850s. [Delve [Burt] 1998, 232,236] After finishing his own examination ordeal, Gaskin acted as a private tutor to prepare Cambridge students for the Tripos for the next twenty years. [Warwick 2003, 156] He acted as Tripos Moderator six times, and published two volumes of solutions to Tripos examinations. His obituarist noted that "[i]t seems to have been his custom to put any new theorem that he discovered in the form of a problem, rather than in that of a paper in a mathematical journal." [Routh 1889, iii]

Mathematical masters in secondary schools also realized the potential the *ET* held for exercising their mathematical powers that had been previously honed through examinations. An anonymous reviewer in the journal *Nature* wrote in 1877 that before first seeing the *ET* 15 years earlier,

> we had in the main confined our mathematical reading to the usual rut passed over by mathematical masters who have only to do with the teaching of ordinary boys; now we were induced to join the, at that date, small band of contributors who rallied round the mathematical editor and derived much pleasure and profit from the study of the many elegant solutions which were constantly being given … this is the sole English periodical (since the demise of the Lady's and Gentleman's Diary) to which mathematicians can send high-class problems. University and college examinations swallow up a great deal of what is produced

54 Buckley, under another pseudonym, "Geometricus," posed 32 questions and solved 17. [Delve [Burt] 1998, 232]

> by residents at the universities, but these pages are open to all comers. [Anonymous 1877]

Mathematical masters and their students at the Dissenters' College in Taunton, in the southwest of England, made a significant number of contributions to the *ET* in its early volumes. One of the students there, William John Clarke Miller (1832–1903) continued to contribute to the department after his graduation while holding teaching positions at several institutions. His family's religious position had made it impossible for Miller to study at Cambridge. However, the problems presented in the *ET* had provided an outlet for his mathematical disposition. [Delve [Burt] 1998, 129, 139] After Wharton's death in 1862, Miller took over the editorship of the mathematical department of the *Educational Times* and held the position until 1897.

As he made the transition from a problem solver to the editor of the mathematical department, Miller "expressed his long-held desire to see original problems posed and solved in the *ET*. He also made his target audience very clear – distinguished mathematicians. His aims were certainly not purely didactic." [Delve [Burt] 1998, 127] Besides changing the character of the mathematical department that had always been pressed for space,[55] Miller wanted to publish a separate reprint of the department. To this end, he solicited the support of mathematicians as subscribers and contributors to his new venture. The reprint, entitled *Mathematical Questions with their Solutions Taken from the "Educational Times"* (*MQ*), began in 1864. This annual publication contained all of the mathematical material from the *ET* and provided extra space for new solutions or papers. After one year, the journal could boast of contributions from British mathematicians, Sylvester,[56] Cayley, William Kingdon Clifford (1845–1879), De Morgan, Isaac Todhunter (1820–1884), and Thomas Archer Hirst (1830–1892) as well as the foreign mathematicians Luigi Cremona (1830–1903) and Pierre Marie Eugène Prouhet (1817–1867). [Delve [Burt] 1998, 115, 316, 322, 325]

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55 During the 1850s, the mathematical department usually occupied a page and a half per each 24-page issue. [Tattersall & McMurran 2007, 70].

56 Recall from above that Sylvester served as one of the early College of Preceptors examiners.

The commitment by several of these mathematicians extended long after the début of the *MQ*. Sylvester's questions appeared in each of the first 70 volumes; [Parshall 1998, 127] he considered that some of those that remained unanswered "really contain the germs of theories." [57] Sylvester, clearly considered the College's journal as a valuable venue for his questions, and he considered the editor to whom he had sent so many questions as

> … an excellent mathematician, extensively and critically versed in all parts of the science, a good writer and lecturer on various subjects of natural science… and a most able and painstaking editor… His scientific attainments are of a high order; he is deeply skilled in nearly all the departments of the highest mathematics,[58] and is a novice in none. His labour as mathematical editor of the *Educational Times*, in which his own original papers are fit company for those of our foremost analysts, is proof of that. It would be a mistake to suppose him a mere schoolmaster or a mere mathematician. He is a sound classical scholar, and an erudite man of letters.[59]

Clifford, like Sylvester, actively contributed to the *MQ*, and he believed that the mathematical department of the *ET* "has done more to suggest and encourage original research than any other European periodical." [60] Until his untimely death in 1879, Clifford "continued to furnish articles that increased in number and value through many volumes, accompanied by letters to the Editor that contained comments and developed views that were often more interesting than the articles themselves." [Finkel 1896, 161] Miller developed extended relationships with world-class mathematicians such as Clifford and Sylvester although he "never broke into the higher echelons of mathematical tutors." [Delve [Burt] 1998, 139] In fact, from 1876 to 1897, he pursued the avocation of mathematical

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57 J.J. Sylvester to William J.C. Miller, 16 Oct. 1865, in [Parshall 1998, 127]

58 While Miller, according to Sylvester, displayed mathematical ability in "nearly all the departments of the highest mathematics," the editor did not evaluate all problems sent to the *ET* on his own. Instead, he utilized a group of mathematicians who would review submitted problems and their solutions before publication. [Tattersall 2011, 81]

59 Sylvester, *Richmond and Twickenham Times* (August 17, 1889); quoted in [Finkel 1896, 162].

60 W.K. Clifford, *Richmond and Twickenham Times* (August 17, 1889); quoted in [Finkel 1896, 162]. For an example of a mathematical question to the *ET* posed by Clifford as well as other sample questions to the *ET*, see [Despeaux 2011a, 160].

journal editor while following the non-mathematical vocation of General Secretary and Registrar of the General Medical Council. [Delve [Burt] 1998, 140]

Clifford and Sylvester had emerged successful from the Cambridge Mathematical Tripos: both were ranked as second wranglers. In fact, at least 253 contributors or subscribers[61] to the *ET* and *MQ* were products of Cambridge; of these, 10% were senior wranglers and 65% were wranglers ranked second or lower.[62] Even counting each of the numerous pseudonyms as separate contributors, the Cambridge group represented 13% of the contributors. Their contributions represent over 30% of all questions and solutions printed. Moreover, 93% of the Cambridge graduates in this group contributed or subscribed to the *ET* and *MQ* after receiving the B.A. degree.[63]

The modest presence of women in the *ET* also had a strong Cambridge slant. While women made only nine contributions before 1871, from 1871 to 1916, they posed around 1.7% of the questions and 6.2% of the solutions. Almost 40% of these problems and solutions came from women educated at Girton College, Cambridge. While women could not obtain degrees from Cambridge until 1948, they were allowed to sit the Tripos examination. [Tattersall & McMurran 2006] The final editor of the mathematical column, from 1902 to 1918, was Constance Marks, who in 1888 had earned a Bachelor of Arts degree from the University of London and in 1903 was elected a Fellow of the London Mathematical Society.

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61 Of these, 11 were subscribers only. The rest posed questions and/or provided solutions.

62 In addition, 14% were Smith's prizemen. Of the 253 from Cambridge, 244 received a B.A. degree or higher, and nine attended Cambridge, but did not obtain a degree (in most cases, because the contributor was female). These statistics are lower estimates; the use of pseudonyms in the *ET* and *MQ* makes the identification of many contributors impossible. This information comes from the prosopographical research on *ET* and *MQ* contributors and subscribers done by James J. Tattersall. Tattersall catalogued every question and solution printed in the*ET* and the *MQ* for the entirety of their runs, with the exception of a few issues for 1850–1852, 1856–1858, 1861, and 1886 that were unavailable.

63 Some of this 93% in addition contributed or subscribed before or during their Cambridge studies. The names only 7% failed to appear in issues printed after the receipt of the degree.

Thirty Cambridge graduates made 100 or more contributions each to the *ET* and *MQ*; their contributions represent 70% of the Cambridge contributions, and over 21% of all contributions to the *ET* and the *MQ*. Of the thirty, all but six were ranked as wranglers, and all but 5 worked as mathematics teachers or professors. The cases of Joseph Wolstenholme (1829–1891), James Andrew Blaikie (1846–1929), Septimus Tebay (1820–1897), and Robert Tucker (1832–1905) provide examples of the careers and interests of these very active contributors.

Wolstenholme, who made 700 contributions to the *ET* and *MQ*, was ranked third wrangler in 1850. Four years later, he acted as a Tripos examiner, a job he would repeat six more times. He often used the Tripos as a forum in which to announce new results; like Gaskin, he often produced his research in the form of a problem rather than a paper. [Warwick 2003, 156] Wolstenholme authored a book of *Mathematical Problems… for the Cambridge Mathematical Tripos Examination*.[64] Besides problems that had already appeared in the Tripos, Wolstenholme explained that "[i]t contains also a certain number (between three and four hundred), which, as I have been in the habit of devoting considerable time to the manufacture of problems, have accumulated on my hands." [Wolstenholme 1878, v.] The second edition of the book contained an additional one hundred problems that had earlier appeared in the *ET*. [Wolstenholme 1878, vi.]

Blaikie, who made 188 contributions to the *ET* and *MQ*, was ranked eighth wrangler in 1870. After serving for a few years as a Mathematical Master in Edinburgh, Blaikie then began a long career tied to examinations. He served successively as an Inspector of Schools, Examiner to the Scottish Education Department and then to the Civil Service Commission, and the Board of Education Examinations. [Venn 1922–1954]

Tebay, who made 159 contributions to the *ET* and the *MQ*, bridged the philomathic and university spheres. While Tebay was employed in a mechanics' shop in Preston, in the north of England, he taught himself mathematics, and began contributing to the *Ladies Diary* and the mathematics

64 On the title page of this work, he included the following quote from poet Alexander Pope (1688–1744): "Tricks to shew the stretch of human brain / Mere curious pleasure, or ingenious pain." [Wolstenholme 1878]

column of his local newspaper, the *Preston Chronicle*.[65] Several gentleman recognized his talent and sent Tebay to study at Cambridge, where he was ranked 27th wrangler in 1856. [Wilkinson 1856, 135], [Delve [Burt] 1998, 137] After obtaining his Cambridge honors, Tebay went on to become a Headmaster at a grammar school in Lancashire.

Tucker made 873 contributions to the *ET* and *MQ*. After graduating as 35th wrangler from Cambridge in 1855, Tucker worked as an Assistant Master at two different schools, and then became Mathematics Master at University College School, a post he held from 1865 to 1899. Besides contributing to the *ET* and the *MQ*, Tucker was incredibly active in the London Mathematical Society. From 1867 to 1902, he served as one of the Society's secretaries and edited the *Proceedings* from its twelfth number to its 766th. [Rice & Wilson 1998, 204] He also served as the Honorary Secretary and Vice President of the Association for the Improvement of Geometrical Teaching. [Venn 1922–1954]

These products of the British examination environment enthusiastically gave their support to the questions and answers genre. To what extent was this genre a British product?

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65 The *Preston Chronicle* ran mathematical questions and their answers as part of its "Correspondence" column in the mid-1840s. Interestingly, the mathematics of this column could appear in poetic form, harkening back to a much earlier tradition of the *Ladies Diary*. For example, question 24 posed by Paul Pry stated:

> "A lady, wealthy, kind, and fair,/ Your aid, dear sirs, would gladly share;
> In finding of a plot of ground,/ Which three right lines exactly bound.
> The space and ambit, that you're told,/ Both the same figure just unfold.
> The sides, more data to supply,/ (Your skill she'd not severely try,)
> Are in Arithmetic train,/ And a right angle, too, contain.
> Now, sure this fair you may relieve,/ And shew what science can achieve."

Septimus Tebay let s, $s + st$, and $s + 2st$ be the three sides of the plot. He obtained 6, 8, and 10 as the answer. [Pry 1845]

The mathematics of the *Preston Chronicle* was not a isolated incident: another weekly newspaper from the North of England, the *York Courant*, ran a mathematics column from 1828 to 1846. [Archibald 1929, 395]

7. MATHEMATICAL QUESTIONS IN U.S., EUROPEAN, AND INDIAN JOURNALS

As Appendix B shows, mathematical questions and answers could be found in a wide variety of short-lived journals in the United States, many of which emulated the *Diary*s. In fact, several of the first editors of these journals had emigrated from Britain and sought to recreate this genre for mathematics in their new home country. For example, George Baron (1769– a. 1811), who edited the first such journal in the U.S., the *Mathematical Correspondent*, emigrated from England and opened a mathematics school in New York. Robert Adrain, an active contributor and later editor of this journal, emigrated from Ireland in 1798. Adrain went on to launch two more mathematics journals in the U.S. William Marrat(1772–1852), who had co-edited the mathematical journal the *Enquirer* in England, moved to New York and established a small mathematical society and the *Monthly Scientific Journal*; both enterprises ended after Marrat returned to his home country. [Parshall & Rowe 1994, 42–45], [Cajori 1890, 95] Charles Gill (1805–1855) began the *Mathematical Miscellany* six years after emigrating to the US from England, where he had been a frequent contributor to the *Ladies Diary* and the *Gentleman's Mathematical Companion.* [Kent 2008, 106]

The British influence on mathematical journalism in the U.S. can also be seen in the almanacs and newspapers that, like those in Britain, contained mathematical columns with questions and answers.[66] As in the case of Britain, U.S. editors sometimes found themselves publishing remaining questions from defunct journals and directing more than one journalistic attempt. On such editor, B. F. Finkel (1865–1947), edited a short-lived mathematics column for a college newspaper, then began the much more successful *American Mathematical Monthly*, which continues to publish mathematical questions and answers to this day. Finkel was an active contributor to the *Educational Times* and an active correspondent with the journal's editor, Miller.[67]

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66 For examples of the almanacs, see [Cajori 1890, 97].

67 In fact, Finkel authored a biography of Miller for his *Monthly* in [Finkel 1896].

Mathematical journals from throughout continental Europe also contained questions and answers. An example from the eighteenth century is the *Mathematische Liefhebberijen*, published in the Netherlands from 1754 to 1764, whose audience consisted for the most part of teachers. [Beckers 2001, 35] Later in the eighteenth century, the short-lived journals *Versuch eines Magazins für die Arithmetik* (1785–1786) and *Arithmetisches Vade-Mecum* (1792–1793) published in German questions and answers on arithmetic. [Morel 2014]

During the nineteenth century, continental Europe enjoyed a wide array of journals containing questions and solutions. For example, in France, questions and answers could be found early in the century in the *Annales de mathématiques pures et appliquées* (1810–1832) of Joseph-Diaz Gergonne (1771–1859).[68] Over 2,500 questions were posed in the *Nouvelles annales de mathématiques* (1842–1927), a "journal des candidats aux écoles polytechnique et normale."[69] Another group of examples comes from the last quarter of the nineteenth century, when several journals associated with mathematics students and teachers were established in France; common characteristics of journals of this group were discussions of examinations and reprints of examination questions.[70] Notably, the journal *l'Intermédiaire des Mathématiciens* (1898–1925) contained only questions and responses, and it sought to act as a clearinghouse of information between mathematicians of differing levels.[71]

University examination questions were also discussed in mathematics journals published in Belgium, for example, *Correspondance mathématique et physique* (1825–1839), *Nouvelle correspondance mathématique* (1874–1880), and *Mathesis* (1881–1962).

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68 For more on this journal, see [Gerini 2002].

69 For more on this journal, see [Rollet & Nabonnand 2010–2011].

70 Journals in this group include *Journal de mathématiques élémentaires* (1877–1980), *Revue de mathématiques spéciales*(1890-present), *Journal de mathématiques spéciales* (1880–1901), *Bulletin de mathématiques spéciales* (1894–1900), *Bulletin de mathématiques élémentaires* (1895–1910), and *l'Éducation mathématique* (1898–1980). For more on these journals, see [Ehrhardt 2014].

71 In all, over 5,500 questions were posed in this journal. For more about this journal, see [Pineau 2006], [Auvinet 2013], and [Romera-Lebret 2014].

University students were explicitly announced as the target audience of the *Giornale di matematiche* (1863–1967); this journal contained a questions section until the end of its first series in 1893.[72] Other examples of mathematical journals of post-Risorgimento Italy containing questions and answers include Giovanni Massa's *Rivista di matematica elementare* (1874–1882) and the *Periodico di matematiche per l'insegnamento secondario* (1886–1918). Near the end of the nineteeth century, Guiseppe Peano (1891–1906) added his *Rivista di Matematica* (1891–1906) to this genre; it was soon followed by the *Bolletino di Matematica e Scienze Fisiche e Naturale* (1899–1916).[73]

Nineteenth-century examples in German include the *Journal für die reine und angewandte Mathematik* (1826-present) of August Crelle (1780–1855), which contained "Sätze und Aufgaben" until 1858 [Archibald 1929, 379], the *Archiv der Mathematik und Physik* (1841–1920), which explicitly announced students and teachers as their its audience,[74] and the *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* (1870–1943).

In the Netherlands, the *Archief, uitgegeven door het Wiskundig Genootschap* (1856–1874), the *Wiskundige Opgaven* (1875–1936), and the *Nieuw archief voor wiskunde* (1875– present) contained questions and answers. These journals were all products of the Amsterdams Wiskundig Genootschap (Amsterdam Mathematical Society), a mathematical society that at first resembled the Spitalfields Mathematical Society, but that later incorporated both amateur and professional mathematicians. [Beckers 2001, 36] Similarly, the Society of Czech Mathematicians and Physicists published 45 problems per year until 1919 in its journal, *Časopis pro pěstování mathematiky a fysiky* (1872–1950).

In Denmark, the *Matematisk Tidsskrift* (1859-present) published "Opgaver" (questions) and solutions until at least 1922. An example from Hungary is the *Mathematikai és Fizikai Lapok* (1892–1943). In the case

72 For more on the *Giornale*, see [Martini 2004, 195–207].

73 Just three years later, at the turn of the century, *Il Bollettino di Matematica* (1902–1948) was founded. In 1949, this journal changed its name to *Archimede* and is still published today. For more on the *Bolletini*, see [Luciano 2014].

74 Its subtitle read "mit besonderer Rücksicht auf die Bedürfnisse der Lehrer an höheren Unterrichtsanstalten." In all, at least 595 questions were posed.

of Romania, mathematical competition through questions and answers in journals, such as the *Gazeta Matematică şi Fizică* (1895– present), was later channeled into the International Mathematical Olympiad, first held there in 1959. While this brief survey of European mathematical journals containing questions and answers is certainly not complete, it gives some indication of the vitality of this genre across the continent especially during second half of the nineteenth century.[75]

Besides those of Europe and the US, Indian mathematicians embraced the mathematical questions genre. An active *ET* contributor, M.T. Naraniengar (1871–1940), served as one of the founding editors of the *Journal of the Indian Mathematical Society*, established in 1908. Around one half of this journal's contents were devoted to questions and answers, and over 1600 questions were posed in the next 22 years. Indian mathematicians had been steadfast contributors to the *ET* since the mid-1870s; in fact, of all *ET* problems, they posed 7.74%, the highest foreign percentage. [Tattersall & McMurran 2007, 70, 73][76]

8. CHANGES AT CAMBRIDGE AND THE END OF THE "PROBLEM AGE"

By the last third of the nineteenth century, mathematical journals containing questions and solutions were being published in Britain, the U.S., and continental Europe. By and large, these journals had close ties to education. In Britain, these ties were interwoven with the omnipresent culture of examinations. However, while "[t]he pressure for the competitive acquisition of knowledge, often for worldly rewards, permeated the social fabric of Victorian education," [MacLeod 1982, 5] change was on the horizon at Cambridge. While it was responsible for much of Cambridge's mathematical flavor, the Tripos examination had, as noted above, tightly circumscribed the mathematical topics studied by students.

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75 Unless explicitly cited, information for this survey comes from [Archibald 1929], [Glaisher 1880], [Rabinowitz 1992], and the author's inspection of some journals.

76 French mathematicians posed 5.56% of the *ET* problems, the next highest foreign percentage, followed by U.S. mathematicians with 5.29%. [Tattersall & McMurran 2007, 70].

In 1867, the Board of Mathematical Studies at Cambridge had come up with a new scheme to allow the subject areas to broaden. The plan, accepted a year later, offered students a wide variety of topics but allowed them to focus on areas of interest. However, as Glaisher observed in 1886, "it was found that, unless the questions were made extremely difficult, more marks could be obtained by reading superficially all the subjects… than by attaining real proficiency in a few of the higher ones; and the best men of the year were tempted, not to say compelled, to extend their reading as widely as possible over the book-work of the whole range of subjects. Thus, with respect to the main object which the framers of the scheme had in view, it was a complete failure." [Glaisher 1886, 23] In 1878, the Board passed a new reform aimed at easing the competitive nature of the Tripos. The first component of the examination retained the traditional ordering of candidates by merit. However, the second component, open only to wranglers, divided the candidates by merit into three classes listed only in alphabetical order. Without the stress of the order of merit, the last part of the examination could involve detailed questions on specialized subjects. [Glaisher 1886, 25–26] Glaisher hailed this new reform as a positive development: "no longer is the wise and thoughtful student hopelessly distanced in the Tripos race by his quick and ready rival." [Glaisher 1886, 31] In his view, while the order of merit had served "as a stimulus to industry, an encouragement to thoroughness in mathematical study, and a paramount influence in regulating elections to fellowships at colleges where no independent examination existed — it has yet been in recent years a deadly enemy to the spread of research and the advance of our science." [Glaisher 1886, 32][77]

Besides being a longtime Cambridge don, Glaisher was an experienced mathematical journal editor. He co-edited both the *Messenger of Mathematics* and the *Quarterly Journal of Pure and Applied Mathematics*, and he alone directed these two journals into the twentieth century until his death in 1928. As editor, Glaisher welcomed research mathematics articles but offered no

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77 For other views of Tripos reform from G.H. Hardy, A.R. Forsyth, and Karl Pearson, see [Hardy 1926]; [Forsyth 1935]; and [Pearson 1936].

place for questions and solutions. He gave his opinion on the question-and-answer genre in an 1880 article for *Nature*, where he evaluated 22 exclusively mathematical journals in existence at that time. Regarding Miller's *Mathematical Questions* as well as four other international journals that contained problems for solution, Glaisher negatively commented:

> The publication of problems and solutions in a mathematical journal is always to be regretted, as it is impossible not to feel that the space might be better occupied, and that the presence of mere exercises in a periodical which should be devoted to the advance of the science is undesirable. Their insertion in several cases is doubtless due to a wish to increase the number of readers by including a class who would take but little interest in, or be unable to follow, original mathematical researches. [Glaisher 1880, 74]

For Glaisher, both the order of merit of the Tripos and the inclusion of question and answers in journals formed a detriment to advancement of mathematics.

By 1906, the order of merit was completely eliminated from the Tripos, and the candidates were last ranked in 1909. [Barrow-Green 1999, 300] Looking back on his days as a Cambridge student, mathematician Henry Ronald Hassé (1884–1955) (7th wrangler for 1905) described the reform was "an event which has profoundly altered mathematical teaching in both universities and schools. This marked the passage from the 'problem age' to the 'example age'; in the former a highly developed technique was demanded of the student, while in the latter an understanding of the theorem which it is intended to exemplify is required." [Hassé 1951, 156–157]

The end of the Cambridge "problem age" corresponded with the end of problems and solutions in the *ET*. By 1915, the *ET* relinquished all problems to the *MQ*, which continued for only three more years.[78]

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78 The end of problems and solutions in the *ET*, however, did not imply the demise of the question-and-answer genre. In Britain, the baton passed to the *Mathematical Gazette*. An official organ of the Mathematical Association, an society for mathematics education, the *Gazette* included problems and solutions beside articles on mathematics and pedagogy. The *Gazette*'s first editor and schoolmaster, Edward Mann Langley (1857–1942), wrote in the first volume of 1894 that "we intend to keep strictly to 'Elementary Mathematics': while not absolutely excluding Differential and Integral Calculus, our columns will, as a rule, be devoted to such school subjects as Arithmetic, Algebra, Geometry, Trigonometry, and Mechanics." [E.M. Langley, "Origin of the Mathematical Gazette," *Mathematical Gazette* 1 (1894), quoted in [Price 1994, 40].]

9. CONCLUSION

While Glaisher held a generally negative opinion about the posing of problems in journals, he did not think that the mathematical genre was without merit:

> [T]he "problem for solution" may even be defended on scientific grounds, as it is a well-known historical fact that not a few of the greatest mathematicians were first led to take a strong interest in mathematics by being tempted in their younger days to attack such questions. It may be remarked also that the mathematical problem has itself undergone great improvement since the days of the *Ladies' Diary*, when the problems usually appeared by the side of the enigmas, charades, &c. These problems were generally merely made-up exercises or puzzles —such as are to be found now only in examination papers— in which the data were wholly fictitious or even ridiculous; the modern problem, especially in pure mathematics, is often a theorem, or a particular case of a theorem, of very considerable intrinsic interest. [Glaisher 1880, 74]

While they initially took the form of "made-up exercises or puzzles," by the mid-eighteenth century, the mathematical problems in the *Ladies Diary* had developed into an arena for competitive mathematics pursued by philomaths. These mathematicians gained their educations outside of the university sphere, and in many cases they were self-taught. The relatively cheap, vernacular *Diary*s provided these mathematical practitioners with a venue to exercise their avocational mathematical skills and to communicate their own style of mathematics.

Northern geometers formed a particular band of editors and contributors to question-and-answer journals around the turn of the nineteenth century. These journals gave them access to mathematicians outside of the groups they formed through informal schools and mathematical societies. Through their mathematical questions and solutions, several of these northern geometers came to be noticed by editor Charles Hutton, who then helped them gain positions at the RMA or RMC.

Langley made 57 contributions to the *ET* and *MQ*. Cambridge graduate William John Greenstreet (1861–1930) assumed the editorship of the *Gazette* in 1898, and continued in this role for over 30 years. He made 371 contributions to the *ET* and *MQ*. For more on the Mathematical Association, and its predecessor, the Association for the Improvement of Geometrical Teaching, see [Price 1994].

For the first half of the nineteenth century, military institutions became a nexus for editors and contributors to the question-and-answer journals. Under the editorships of Leybourn and Gregory, and later Davies, Fenwick, and Rutherford, these journals began to include original mathematical articles, and the level of the mathematical questions increased.

The sheer variety and number of these mathematics journals implies the devotion that this genre enjoyed. The extremely short lifespan of all but a few of the journals shows that devotion was not enough. Question-and-answer journals always faced financial strain, and none of them enjoyed the financial backing of a national society or academic institution: they were, at heart, commercial affairs. However, the job of editor of one of these enterprises was taken on as a labor of love rather than as a means to fame and fortune. As one journal failed, another soon took its place. The genre had enough support to enable it to continue throughout the eighteenth and nineteenth centuries in Britain, although under constantly changing guises. The only constant was the *Diary*, but by 1871, it too had come to an end.

The *ET* carried the genre into the twentieth century, but it found support from a mathematical practice quite different from the one of avocational problem-solving of the eighteenth and early nineteenth centuries. Examinations engulfed Victorian education, and they fostered a taste for mathematical problem solving among the successful products of the new system. Mathematicians who had successfully passed the challenge of the Cambridge Tripos examinations, in particular, enthusiastically supported the *ET* by posing and solving a sizable proportion of its problems.

This particular taste for problem solving made the contributorship of the *ET* resistant to stratification at the same time that British mathematics was becoming professionalized. Leading lights in British mathematics posed problems beside provincial school masters. Conversely, however, professional mathematicians had created boundaries around their own specialized journals. In terms of its contributors, the journalistic genre of questions and answers formed a concentric circle around the research core.

While the British question-and-answer journals were notable for their sheer number and variety, the genre was not a distinctly British product.

Mathematical journals from continental Europe included questions and answers, although, in most cases, in journals explicitly aimed at students and teachers. The U.S. version of the genre was active, diverse, and initially modeled on the British version. Indian mathematicians who had enthusiastically contributed to the *ET* went on to create their own venue for mathematical questions and answers.

The question-and-answer mathematical genre in Britain provided a publication venue for particular form of communication. Mathematics was discussed in a lively, competitive atmosphere, where contributors and editors pursued mathematics side by side. Converging practices brought the academic and avocational mathematical spheres in contact, and they carried this particular form of mathematical communication into the twentieth century.

APPENDIX A
A SAMPLE[79] OF BRITISH PERIODICALS FROM THE 18TH AND 19TH CENTURIES CONTAINING MATHEMATICAL QUESTIONS AND ANSWERS

Title	Editor(s)	Years/ vols or numbers	Description
Ladies Diary	Succession of 9 editors (**3** military)	1704–1840 (137 vols)	Original math'l articles, almanac information, enigmas, rebuses, and charades. In all, 1778 questions plus prize questions.
Delights for the Ingenious	John Tipper	1711 (8 nos)	Math'l questions and enigmas
Miscellaneae Curiosae	Thomas Turner	1734–1735 (6 nos)	Subtitle: "entertainment for the ingenious of both sexes"
Gentleman's Diary	Succession of 6 editors (5 northern; **2** military)	1741–1840 (100 vols)	Enigmas, rebuses, and charades; almanac information; 24-page math'l appendices from 1835–1839. In all, 1424 problems posed.
Supplement to the Gentleman's Diary	*G. Diary* eds. and "a Society of Gentlemen"	1743–1745 (3 nos)	Contained overflow from *Gentleman's Diary*

79 This sample contains 34 out of the 43 periodicals discussed in [Archibald 1929]. [Archibald 1929] lists 8 more by title only. [Archibald 1929] contains all 33 question-and-answer journals listed in [Brierley 1878]. Editors in **bold** worked at RMC or RMA. Underlined editors were from the north of England.

Miscellanea Curiosa Mathematica	Francis Holliday	1745–1753 (14 nos)	Math'l essays as well as questions and answers.
Mathematician	Edward Rollinson, **Thomas Simpson**, John Turner	1745–1750 (6 nos)	Subtitle: "containing many Curious Dissertations on the Rise Progress and Improvement of Geometry." In all, 90 questions posed and answered.
Mathematical Exercises	John Turner	1750–1753 (6 nos)	Began right after *Mathematician* ended. Ended as soon as Simpson began editing the *Ladies Diary*. In all, 81 questions.
Palladium (many variants on this title)	Robert Heath	1749–1779 (17 nos)	Heath began this journal while editing the *Ladies Diary*. He began it in opposition to Company of Stationers monopoly on almanacs; he also battled with *Ladies Diary* contributors on its pages. In all, 631 questions posed.
Miscellaneous Correspondence	Benjamin Martin	1755–1763 (108 nos)	Contained a section for math'l questions/answers, correspondence, and articles.
Imperial Magazine	unknown	1760–1762 (29 nos)	1–3 pages of questions and answers in each number
Town and Country Magazine	Samuel Clark (until 1784)	1769–1792 (24 vols)	1–3 pages of questions and answers in most numbers of first 16 vols.
Diarian Repository	Samuel Clark	1771–1774 (30 nos)	Rival to *Diarian Miscellany*. Collection of *Ladies Diary* questions from 1704–1760.
Diarian Miscellany	**Charles Hutton**	1771–1775 (14 nos)	Reprint of math'l and poetical parts of the *Ladies Diary* from 1704 to 1773. Restated rhyming problems in prose, provided more extensive answers.
British Oracle	unknown	1769–1770 (12 nos)	Subtitle: "Consisting of Questions, Essays, and Dissertations in Natural Philosophy and the Mathematics." In all, 127 questions posed; 107 answered.
Miscellanea Mathematica	**Charles Hutton**	1771–1775 (13 nos)	Continued and completed some articles and problems from the *British Oracle*. In all, 116 questions posed.
The Lady's and Gentleman's Diary, or Royal Almanack	Reuben Burrow	1776–1788 (13 vols)	Also known as *Carnan's Diary*. In all, 171 questions posed; 157 answered.
Lady's and Gentleman's Scientifical Repository	William Spalton and Joseph Gales	1783–1784 (10 nos)	Subtitle: "containing, Enigmas, Rebuses, Paradoxes, Philosophical, and other Useful Queries; Arithmetical and Mathematical Questions and Problems, with their respective Solutions"

Diaria Britannica	John Cotes, George Taylor, Patrick Hall	1787–1795 (9 nos)	Published some questions and solutions from a previous, defunct journal called the *British Miscellany*
Scientific Receptacle	Thomas Whiting	1791–1819 (26 nos)	Subtitle: "containing curious original mathematical Questions and Solutions… selected from an extensive Correspondence, and intended to promote Emulation in the Ingenious of both Sexes"
Mathematical, Geometrical, and Philosophical Delights	Thomas Whiting	1792–1798 (11 nos)	Subtitle: "containing Essays, Problems, Solutions, Theorems, Etc. selected from an Extensive Correspondence." In all 192 questions posed.
Mathematical Repository	**Thomas Leybourn**	1795–1835 (38 nos)	Original articles and translations. In all, 940 questions posed. 2 series.
Student	John Knowles and William Hilton	1797–1800 (4 nos)	Questions and answers; French and Latin excerpts for translation; enigmas, rebuses and charades; "Polite and useful arts," "Natural and Experimental Philosophy," "Theoretic and Practical Chemistry"
Gentleman's Mathematical Companion	William Davis and John Hampshire	1797–1826 (30 nos)	Original math'l articles, math'l reprints, enigmas, rebuses and charades. In all, 886 questions posed.
Enquirer	William Marrat, Pishey Thomson, J. Moore	1811–1813 (11 nos)	Original math'l articles, math'l reprints, junior math'l section; French and Latin excerpts for translation; essays on a variety of topics in the arts and sciences. In all, 155 questions posed.
Quarterly Visitor	William Passman	1813–1815 (12 nos)	Original math'l articles, French and Latin excerpts for translation, "Memoirs of Eminent Men," book reviews. In all, 135 questions posed.
Leeds Correspondent	John Ryley, John Gawthorp, John Whitley	1814–1823 (19 nos)	Original math'l articles, math'l reprints, junior math'l section, scientific extracts, French and Latin excerpts for translation. In all, 300 questions posed (some continued from *Enquirer*), plus prize questions.
Scientific Receptacle	Henry Clay	1825–1825 (4 nos)	Junior math'l section, enigmas, rebuses and charades, French and Latin excerpts for translation. In all, 76 questions posed.

Student's Companion	Charles Holt	1822–1823 (2 nos)	Junior math'l section, enigmas, rebuses and charades, French and Latin excerpts for translation. In all, 32 questions posed.
Liverpool Apollonius	J. H. Swale	1823–1824 (2 nos)	Original math'l articles, math'l reprints, junior math'l section. In all, 30 questions posed, plus prize problems.
Scientific Mirror	Charles Holt	1829–1830 (2 nos)	Junior math'l section, enigmas, rebuses and charades. In all, 32 questions posed.
The York Courant Math. Column	T.T. Tate William Tomlinson	1828–1846	A weekly newspaper. Included junior section. As the contributors became more competitive,"increasingly irascible and, in one case, 'insolent'," the column introduced prize questions to channel this aggressiveness. [Howson & Black 1979, 92, 95–96]
The Private Tutor	J. M. F. Wright	1830–1831 (2 vols)	Essays, exam discussions, problems and solutions. Appeared weekly.
Northumbrian Mirror	W. Telfer, **Stephen Fenwick**	1837–1841 (15 nos)	Original math'l articles, math'l reprints, junior math'l section, enigmas, rebuses and charades, French and Latin excerpts for translation. In all, 225 questions posed. Subtitle: "forming an introduction to the *Ladies Diary*"
Lady's and Gentleman's Diary	W.S.B. Woolhouse	1841–1871 (31 vols)	Continuation of the *Ladies Diary* and the *Gentleman's Diary*. Included 24-page math'l appendices from 1842–1865
Mathematician	**T.S. Davies**, **Stephen Fenwick,** **William Rutherford**	1843–1850 (19 nos)	Original math'l articles and math'l reprints. In all, 189 questions posed.
Preston Chronicle Math. Column		1844–1845	A weekly newspaper. In all, at least 27 questions posed.
Educational Times (ET)	J. Wharton, R. Wilson, W.J.C. Miller, & others	1847–1923 (75 vols)	Original math'l articles and math'l reprints. In all, 18,139 questions posed up to 1915. Issued monthly. Journal continued as *Education Today*.
Mathematical Questions . . . from the "ET"	W.J.C. Miller, D. Biddle, C. Marks	1864–1918 (110 vols)	Original math'l articles and math'l reprints. In all, 18,702 questions posed. 3 series. Ser.1 and 2 semiannual; ser. 3 monthly.

Mathematical Gazette	E.M. Langley, F.S. Macaulay, W.J. Greenstreet, & others	1894-present	Articles, examination questions, questions for students. Official organ of the Mathematical Association. "Problem Corner" continues today.

Information for Appendix A was compiled from [Archibald 1929], [Delve [Burt] 1998], [Carlson 1938], [Albree & Brown 2009], [Warwick 2003], [Wilkinson 1848b], [Wilkinson 1848a], [Wilkinson 1849c], [Wilkinson 1849d], [Wilkinson 1852b], [Wilkinson 1852a], and the author's inspection of some journals. Editors in **bold** worked at RMC or RMA. Underlined editors were from the North of England, a region defined as lying above the counties of Gloucestershire, Warwickshire, Leicestershire, and Lincolnshire. For a map, see `http://www.sasi.group.shef.ac.uk/maps/nsdivide/index.html` from the Department of Geography at the University of Sheffield.

APPENDIX B
PERIODICALS FROM THE UNITED STATES CONTAINING MATHEMATICAL QUESTIONS AND ANSWERS

Title	Editor(s)	Years	Description
Mathematical Correspondent	George Baron, Robert Adrain	1804–1806	Format modeled on the *Ladies Diary*. Included articles and prize problems. More than 82 problems posed.
Analyst or Mathematical Museum	Robert Adrain	1808, 1814	Included articles and prize problems. In all, 46 problems posed.
Monthly Scientific Journal	William Marrat	1818	Concluded when Marrat moved back to England.
Ladies' and Gentlemen's Diary or United States Almanac	Melatiah Nash	1820–1822	An almanac with enigmas, charades, and a math'l problems section.
Mathematical Diary	Robert Adrain	1825–1832	Included prize problems. In all, 229 problems posed. Editor mentions many British question-and-answer journals in the preface.
Mathematical Companion	J.D. Williams	1828–1831	Included prize problems. In all, over 36 problems posed, plus 27 junior questions.
Mathematical Miscellany	Charles Gill	1836–1839	Included articles. More than 127 senior problems and 35 junior problems posed.

Cambridge Miscellany of Mathematics, Physics, and Astronomy	Benjamin Peirce, Joseph Lovering	1842–1843	Included articles, junior section. Junior section continued some questions from the *Mathematical Miscellany*. In all 20 junior problems and 24 senior problems posed.
Analyst: a Journal of Pure and Applied Mathematics	J.E. Hendrick	1874–1883	Articles and questions for solution. In all, 444 problems posed.
Mathematical Monthly	J.D. Runkle	1858–1861	Articles, questions for students, prize problems.
Yates County Chronicle Math. Column	S.H. Wright	1872–1880	Weekly newspaper with a mathematical problems column. Editor contributed to *ET* and modeled his column on it. In all, 2,517 problems posed.
Mathematical Visitor	Artemas Martin	1878–1894	Junior, senior, and prize problems, short articles, book notices.
Mathematical Magazine	Artemas Martin	1882–1884	Subtitle: "A Journals of Elementary Mathematics." Short notes and problems for solution.
Annals of Mathematics	Ormond Stone & others	1884–present	Contained problems from the defunct *Analyst*. Problem section ended in 1896. In all 406 problems.
School Messenger	G.H. Harvill	1884–1894	Subtitle: " A Journal Devoted to Elementary Mathematics, Queries, and Answers on Grammar, History, Philosophy, Geography, &c."
Ohio Normal University Herald Math. Column	B.F. Finkel	1885–1887	College newspaper with a math'l column. In all 114 problems.
American Mathematical Monthly	B.F. Finkel & others	1894-present	Articles, plus problems and solutions that continue today.

Information for Appendix B was compiled from [Cajori 1890, 94–97], [Finkel 1940], [Finkel 1941], [Finkel 1942b], [Kent 2008], [Parshall & Rowe 1994, 51], [Tattersall 2009], [Tattersall 2014b], [Tattersall 2014a], and [Zittarelli 2005].

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