

Chapter 2

The Popularization of Science

2.1 Overview

In the introduction to her most famous work *Conversations on Chemistry* (1806), Jane Marcet explained she had been frustrated upon attending public experimental lectures, finding it difficult to follow the experiments because she lacked necessary background knowledge. But she found that

frequent opportunities having afterwards occurred of conversing with a friend on the subject of chemistry, and of repeating a variety of experiments, she became better acquainted with the principles of that science, and began to feel highly interested in its pursuit. It was then that she perceived, in attending the excellent lectures delivered at the Royal Institution, by the present Professor of Chemistry, the great advantage which her previous knowledge of the subject, slight as it was, gave her over others who had not enjoyed the same means of private instruction. (Marcet 1817: v–vi)

Marcet's epiphany should not surprise any science educator; hands-on laboratory exercises done *by* the students are clearly more effective than passive demonstrations presented *to* the class, and the seamless integration of lab experiences with a seminar or lecture offers students necessary context for the theoretical framework of the laws of nature.

In the Internet Age, members of the general public who do not have the free time or opportunity to attend a class at a local community college, or who desire additional background material concerning what they have experienced at a museum, planetarium, or public lecture (or viewed on television or read online), have countless YouTube and Khan Academy videos and TED talks offered by science media superstars from which to choose. They might even elect to read a book on the subject carefully crafted for a general, nontechnical audience (precisely what Marcet offered to her own readers). These technologies—books, museum displays, public lectures, planetarium shows, demonstrations, documentaries, MOOCs and tutorials—are examples of what is now termed the *popularization of science*.

Today the popularization of science is big business. For example, Stephen Hawking's infamously abstruse 1988 popularization *A Brief History of Time* had sold over 10 million copies by 2013 (Leane 2017). But those who create these myriad modes of science popularization have come under criticism from the scientific community for promoting, if not overt misconceptions, then oversimplifications in an attempt to stress entertainment over education (Bratton 2013). As this book will demonstrate, both the phenomenon of science popularization and criticisms of it are not novel, and indeed in some ways have changed little since the nineteenth century.

There were several different nontechnical audiences to which popularizers of science could market their works in the nineteenth century. At the least technical level were children. Despite the lack of opportunities for women at the more technical levels of science, science books for children appear to have been inclusive, aimed at both boys and girls (Fyfe 2003). The women who were these children's teachers, tutors, and mothers (often serving in several of these roles simultaneously) were also in need of accessible information on the latest discoveries in science. In addition, there was an increasing audience of working-class men who were also interested in scientific topics, but did not have the background nor disposable income to make expensive tomes written by scientists for other scientists a good fit to their needs. Therefore adult women and men often read children's science books as well, as publishers did not take advantage of this lucrative market until nearly mid-century (Fyfe 2003). This phenomenon occurred on both sides of the Atlantic, and between public lectures and demonstrations and popular-level and children's books, the popularization of science in both Britain and America reached nearly a fever pitch by 1850 (Kohlstedt 1990).

While there are a number of similarities between the movement to popularize science in the nineteenth and twentieth centuries, there are two significant differences, the first being one of the central reasons for bringing science to nonscientists in the nineteenth century, and the other the demographics of the authors to whom the responsibility for writing these works fell. In the nineteenth century science was widely utilized as vehicle through which to teach piety and proper behavior, especially to children and young ladies. The lessons of the natural world were intended not only to educate, but to inspire, in a religious sense, as seeing God's hand reflected in his handiwork was often considered more important than knowing the science itself (as described by Edward Hitchcock [Sect. 1.3]) (Fyfe 2008).

What is of interest is that many of these early superstars of science popularization in the nineteenth century were not practicing scientists at all, but instead teachers, tutors, and amateur enthusiasts, many of whom were self-taught in the very subject they attempted to explain to a general audience. And, not coincidentally, they were female. While many of their names are nearly forgotten today, a handful persist in the history of science, held up as curiosities, exceptions to the rule of the sexist scientific establishment of their century. One such example is Mary Somerville and her wildly popular *On the Connexion of the Physical Sciences* (1834). But Somerville also wrote a highly influential book on Physical geography that deserves

far more analysis by historians of science than it has received.¹ For this reason, she is the subject of [Sect. 9.3](#).

Admittedly the current lack of name recognition of these women is not merely due to their gender. Until recent decades, the popularization of science in general was not a topic of wide interest to historians of science due to the relative unimportance with which popularization was considered (Cooter and Pumfrey 1994). According to the positivist diffusion model of science that held sway over much of the twentieth century, scientists held the privileged active position of being the sole producers of knowledge. The popularization of science was considered to be a low-status activity that was not worth the time of scientists themselves. This caste system in communicating science mandated that scientists spoke to each other through peer-reviewed journals and left the popularization of science to journalists and those without the academic credentials to be practicing scientists (Hilgartner 1990; Whitley 1985).² While some well-known scientists took an active role in the popularization of science in the early twentieth century, for example astronomer Sir James Jeans in Britain, by the late twentieth century those scientists who chose to speak with the general public found themselves *Saganized*, a pejorative term referring to Pulitzer Prize winning astronomer Carl Sagan, who suffered backlash from the scientific community for his media efforts to bring science to the average person. As with other aspects of the popularization of science, this is also not a new phenomenon. In his *Discourses: Biological and Geological Essays* (1898), Thomas H. Huxley warned that “the popularization of science, whether by lecture or essay, has its drawbacks. Success in this department has its perils for those who succeed. The ‘people who fail’ take their revenge... by ignoring all the rest of a man’s work and glibly labeling him a mere popularizer” (vii–viii).

While the popularization of science has become less openly derided in recent decades (due, in part, to the best-selling books of physicist Stephen Hawking and paleontologist Stephen Jay Gould, among others), scientists who engage in popularization can still face prejudice from the scientific community when applying for grants or when applying for promotion or tenure. The logic is that if one is devoting time to popularization, one’s true scientific work (i.e. research) must be suffering in the process (Ellison 2004). Such prejudice is partly behind efforts to avoid the term *popularization* and replace it with *expository science*, a term with less political baggage (Cooter and Pumphrey 1994).

At the heart of this prejudice is a patent misunderstanding of the nature of popularization, of conflating it with merely simplifying—of watering-down—the pure science in order to make it palatable to the general public (Gavroglu 2012). Increasingly both scientists and historians of science have come to understand that the effective popularization of science requires two skill sets rather than one; not only does the author have to possess an understanding of the science at hand, but the

¹For more information on the popularization of science in general in the nineteenth century, see Shtier (1996), Gates (1998), Lightman (2007), and O’Connor (2013).

²For an overview of the politics surrounding the popularization of science, see Bensaude-Vincent (2009).

effective communication skills to *translate* the science into a more common vernacular. This is no mere simplification. There is therefore not only room for, but a need for, both those who create the scientific knowledge and those who more widely disseminate it beyond the technical discipline.

As both the early nineteenth century and twenty-first century scientific communities have shown, there is sufficient space for researchers, educators, and authors in science; however, as discussed in [Sect. 1.4](#), this was a highly gendered space in the nineteenth century, with women being relegated to clearly limited and secondary roles. In particular, the popular-level scientific literature of the 1700s and 1800s also reflected a gender segregation by discipline. Certain sciences and subspecialties were considered appropriate for women to write about, while others were deemed the province of men. Perhaps the premier example of a female-friendly science was botany, while physics and chemistry were largely considered part of the realm of men. However, there have always been individual women who chafed against the hegemony, and refused to be relegated to the sidelines. Two important examples are Mary Somerville, as seen in her aforementioned bestseller *On the Connexion of the Physical Sciences*, and Jane Marcet's *Conversations on Chemistry*. In particular, Marcet's work demonstrated the pedagogical power of uniting a nontechnical explanation of science with opportunities to experience science through hands-on experimentation: the ability to *do* science, even at a simplistic level. This marriage of literature and science led to a revolution of science-based literature largely written by women for women (and their children) called the *familiar format*.

2.2 Defining the Familiar Format in Science Writing

As previously noted, a market for popular-level books on science (especially aimed at an audience of children and women) opened up in the late eighteenth century. But this new audience required an equally novel style of writing, meant to effectively transmit scientific knowledge to those with a minimal background in science. This methodology soon became known as the *familiar format*, or alternately the conversational style (although the conversational aspect was merely one of the defining characteristics of this type of writing). While a number of scholars have described this literary style (e.g. Shteir [1996](#); Gates [1998](#); Fyfe [2003](#); Lightman [2007](#); Larsen [2014](#)) as well as offered specific examples of it (most often in botanical texts, where it achieved its widest usage), it is difficult to find a detailed template for what constituted a true work in the familiar format, as well as an analysis of exactly how much latitude the authors had in branching out from what soon became a literary trope. Such a detailed analysis forms the backbone for much of the rest of this volume.

While there was certainly considerable variety in the works themselves, there are seven common characteristics that appear to be central to the genre's characterization:

1. The audience is presumed to be laypersons (including children, women, and working class men), and as such, the works are openly adapted by the author for their audience. This includes simplifications (often including a lack of mathematics) or some other intentional adaptation to the background and abilities of the audience. The exact type of adaptation is usually directly addressed by the author, often in the preface or introduction, and may also explain to the audience what is expected on their side. As will be shown, this does not necessarily include the watering down of scientific terminology (although some terminology may be relegated to an appendix attached to the work proper);
2. The literary style is most often that of a fictional dialogue or letters, rather than a lecture written in third-person. Note that there is a wide latitude found in the depth of the characters; in some cases the individual characters are well fleshed-out and have distinctive personalities and backgrounds, giving the work a rather novelistic feel. Also included in this literary style are one-sided conversations where the author appears to be speaking *with*, rather than formally lecturing *to*, the anonymous audience/reader (often made clear through the use of more personal first-person rather than formal third-person pronouns), as well as catechisms;
3. The authority figure who imparts the scientific knowledge to the other characters (and hence the audience) is either a woman (a mother or tutor) or, less frequently, a pair of parents. In the latter case, the mother takes an active role in describing science, although this role may be obviously both secondary and subservient to the role of the father;
4. The work is set in a domestic setting, usually either a home or garden, or more generally outdoors, rather than a lecture hall or formal classroom. This affords ample opportunities for experimentation and observation in a comfortable and informal manner;
5. The characters are actively engaged with the natural world as part of the learning process. They make observations, gather samples, and often gain hands-on experience with technology (such as microscopes or goniometers). If the work is written in the form of a catechism or one-sided author conversation with the reader, the reader/student is clearly directed to engage in observation and hands-on learning by the author/teacher;
6. Everyday examples and common metaphors are often used to describe the science. Experiments may be done using household items (as seen in Fig. 2.1) and the science of these items may likewise be explained;
7. Morality and religiosity are often clearly and repeatedly reinforced by the author/authority figure. The benefit of scientific study (especially its ability to reinforce ethical behavior and religious piety) is normally stressed.

Between 1780 and 1840, this format was adopted by a number of writers of science works for children and women, and afforded women a gender-appropriate space within specifically science writing and education, but more broadly within the scientific endeavor. Fyfe (2008) notes that the genre reached its peak early in the nineteenth century, with an average of two scientific *Conversations* published per



Fig. 2.1 Spinning a clay ball on a stick to represent the oblate spinning earth. Reproduced from Delia W. Godding (1847) *First Lessons in Geology*

year in the 1820s. The title page of a representative example is shown in Fig. 2.2. The use of letters or conversations to communicate science was not a novel idea, having been previously used by such illustrious (male) scientists as Galileo Galilei and Robert Boyle (Shteir 1996; Gates 1998).

The appearance of science in a domestic setting not only echoes the argument of feminist writer Mary Wollstonecraft (1759–1797) that education should reflect the everyday experience of each individual (Shteir 1996), but also the architecture of the day. In Europe, the availability of salons and drawing rooms offered a natural space in which myriad topics of interest, including politics and science, could be discussed in comfort, leading to the salon tradition that played a central role in the dissemination of scientific knowledge to women of the upper socioeconomic classes. In the United States, most middle-class homes had parlors, rooms where visitors were welcomed, conversations held, and books housed. For example, Yale geologist Benjamin Silliman recalled reciting lessons with his siblings in his family's parlor, demonstrating the use of the parlor as an educational space (Kohlstedt 1990). Not only were these parlors furnished with tables, chairs, and bookcases, but given their ceremonial purpose as a welcoming space for guests they would have also been the location of the family's natural history cabinet. For these reasons as

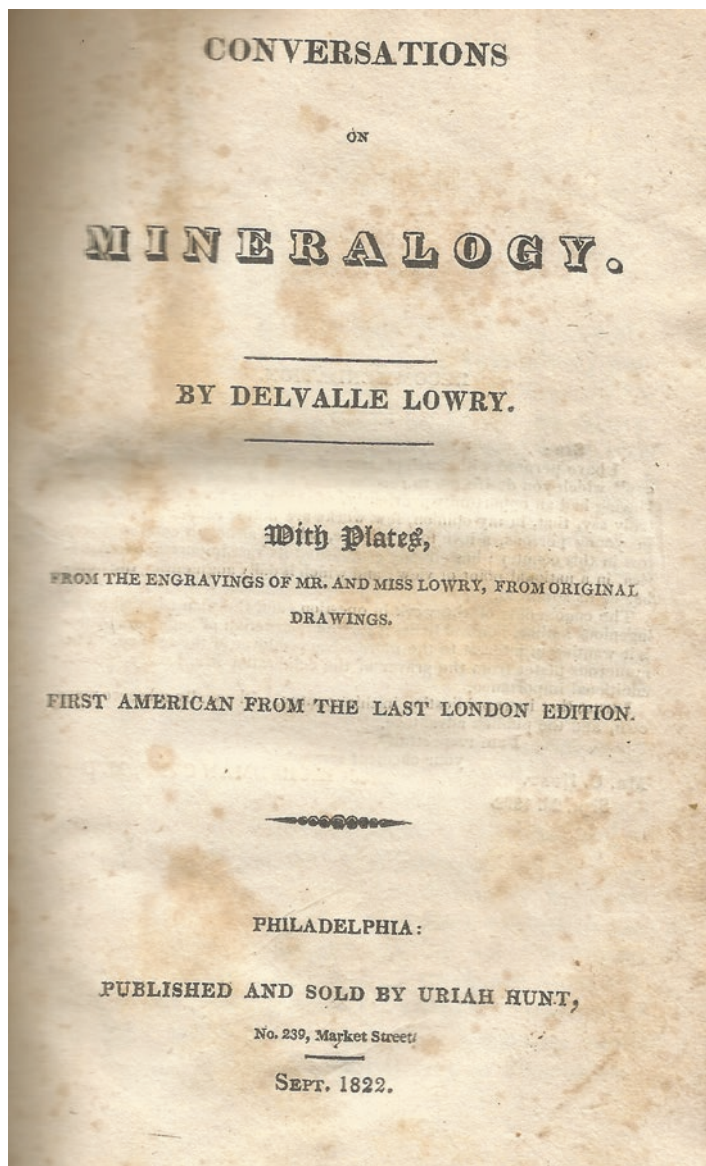


Fig. 2.2 Title page. Reproduced from Delvalle Lowry (1822) *Conversations on Mineralogy*, Amer. Ed

well, the parlor would have afforded a convenient space for scientific investigations, such as using microscopes and magnifying glasses to examine the fossils and minerals that could have been collected on everyday walks (depending on the geographic location).

This domestic setting, in turn, helped to confirm that the matriarchal transmission of scientific knowledge was a societal expectation as part of a woman's household duties. In teaching science, these teacher/mothers were also afforded additional opportunities to reinforce moral lessons and an appreciation for scriptural teachings (Shteir 1997). But in order to teach science to their children, these women first had to educate themselves, through being tutored by a male relative or husband, attending public lectures, or reading books (and sometimes scientific papers) written by scientists. In order to aid other women in this endeavor, some turned to writing popularizations themselves. In order to understand not only the breadth of the genre but how it incorporated the properties listed above, and to properly situate the familiar format writings in the geological sciences of British writers Jane Marcet, Maria Hack, and Delvalle Lowry, and Americans Jane Kilby Welsh, Delia Woodruff Godding, and Almira Hart Lincoln Phelps, it is necessary first to explore the wider landscape of the genre and carefully differentiate mere conversations from the true familiar format. The remainder of this section will focus on examples of conversations and the familiar format from the physical sciences (including works by male writers in geology), while the following section will specifically focus on early influential women writers in the genre, particularly in botany, the science in which female writers of the familiar format found the warmest welcome. These works are vital to explore, as not only were they read and cited by the women whose work forms the core of Chaps. 3–8, but provided them with a ready-made audience that had demonstrated its eagerness for popular-level science works written in this format.

One of the most influential works in the familiar format (and the most commonly cited work in the genre) is Jane Marcet's *Conversations on Chemistry*. As previously noted, in her preface Marcet explains that the work was precipitated by her own experiences in attempting to understand public demonstrations and lectures. Based on her experiences, she wrote the book in order to instruct beginners, and most especially women, in the basics of chemistry by mimicking the form of her own instruction: conversation and experimentation. Marcet notes that as a woman "venturing to offer to the public, and more particularly to the female sex, an Introduction to Chemistry," she needed to explain to her audience (and those male reviewers who might look askance at such a bold work) her own background in the subject (Marcet 1817: v). Despite the fact that she admitted some apprehension in proposing a work which might be considered by some "unsuited to the ordinary pursuits of her sex," she "felt encouraged by the establishment of those public institutions, open to both sexes, for the dissemination of philosophical knowledge, which clearly prove that the general opinion no longer excludes women from an acquaintance with the elements of science" (Marcet 1817: ix). However, it must be noted that there is a significant difference between allowing women to attend public lectures in the physical sciences and accepting them as authors of works in these historically male sciences, especially a work which was originally published anonymously. To Marcet's undoubted surprise, *Conversations on Chemistry* was widely-acclaimed, and enjoyed numerous editions in both England and the United States. The work's most famous reader was scientist Michael Faraday, who received his first introduction to

electrochemistry through its pages while he was a young bookbinder. In his later years he often gave credit to Marcet for sparking his interest in chemistry.

As she begins her book, Marcet is fully aware of the potential anxieties of her audience, and explains that

it was natural to infer, that familiar conversation was, in studies of this kind, a most useful auxiliary source of information; and more especially to the female sex, whose education is seldom calculated to prepare their minds for abstract ideas, or scientific language. As, however, there are but few women who have access to this mode of instruction; and as the author was not acquainted with any book that could prove a substitute for it, she thought that it might be useful for beginners, as well as satisfactory to herself, to trace the steps by which she had acquired her little stock of chemical knowledge, and to record, in the form of dialogue, those ideas which she had first derived from conversation. (Marcet 1817: vi–vii)

Given the wide popularity of her work, the familiar format proved a powerful pedagogical tool when wielded by her hand.

Perhaps the breadth of Marcet's influence on science writing is best seen in a short-lived expansion of the familiar format that her works sparked. Even Charles Lyell himself considered writing a geological conversation, but thought against it, given the limitations of the style. In an 1828 letter to Gideon Algernon Mantell, Lyell explained

I at first intended to write 'Conversations on Geology:' it is what no doubt the booksellers, and therefore the greatest number of readers, are desirous of. My reason for abandoning this form was simply this; that I found I should not do it at all, without taking more pains than such a form would do justice to. Besides, I felt that in a subject where so much is to be reformed and struck out anew, and where one obtains new ideas and theories in the progress of one's task, where you have to controvert, and to invent an argumentation—work is required, and one like the 'Conversations on Chemistry' and others would not do.... But finally, I thought, that when I had made up my own mind and opinions in producing another kind of book, I might then construct conversations from it. In the meantime there is a cry among the publishers for an elementary work, and I much wish you would supply it. Anything from you would be useful.... (Lyell 1881: 177)

Lyell instead wrote his classic (and traditional lecture-style) text *Principles of Geology* (in three volumes published between 1830 and 1833) and *Elements in Geology* (1838) and never wrote a conversation-based geology book.

Not all so-called familiar books are written in a truly familiar format (using the seven points previously identified for the genre). For example, British mineralogist John Mawe's *Familiar Lessons on Mineralogy and Geology* (1819) is written in straightforward lecture style. Despite this it proved so popular that by 1830 it was already in its 12th edition.

Mantell eventually wrote several popular-level works in geology, most notably *The Wonders of Geology; or, a Familiar Exposition of Geological Phenomena* (1838) and *The Medals of Creation; or First Lessons in Geology and in the Study of Organic Remains* (1844). Neither of these works used the conversation style. A book entitled *Conversations on Geology* did appear in 1828, with the cumbersome subtitle "Comprising a familiar explanation of the Huttonian and Wernerian systems; the Mosaic geology as explained by Mr. Granville Penn; and the late discoveries of Professor Buckland, Humboldt, Dr. Macculloch, and others." The book,

published anonymously but now attributed to Scottish naturalist James Rennie (1787–1867), was considered such an enthusiastic promotion of Penn’s Mosaic geology that through the mid-twentieth century many scholars attributed it to Penn himself (O’Connor 2007).

In Rennie’s work a fictional Mrs. R explains the various systems of geology to her inquisitive children Edward and Christina. As is common in the familiar format, Rennie offers to his audience that he has two reasons for writing this book; to “describe the various Theories of the Earth and Systems of Geology which have, from time to time, prevailed, and have brought forward facts and reasonings either in support or contradiction of them” and to make the reader “enabled to ‘Look through Nature up to Nature’s God’” (Rennie 1828: vi). He then includes five pages of quotes from William Buckland supporting the view that the earth has been designed by God for the benefit of humanity. The first conversation is on “Theories of the Earth” and starts with Edward asking his mother about seashells found “in the heart of solid rocks, and far inland” (Rennie 1828: 1). She explains that “The history of the shells, my dear, and many other things no less wonderful, is contained in the science called GEOLOGY, which treats of the first appearance of rocks, mountains, valleys, lakes, and rivers; and the changes they have undergone, from the Creation and the Deluge, till the present time” (Rennie 1828: 3). Note that the Biblical chronology is assumed to be factual from the start of the text. Edward is afraid that he won’t be able to understand the science, so he asks if there is an “easy book on Geology, like the delightful ‘Conversations on Chemistry,’ which I could read without being puzzled?” (Rennie 1828: 4). His mother explains that geology is too young a science for such a book to exist, but she is willing to try and teach him without a book, and the conversation unfolds.

Religious and moral lessons play a central role in this work, as well as the role of geology in teaching both. For example, Mrs. R opines that “Geology is, perhaps, better fitted for our limited comprehensions than astronomy; for it is more within our reach to examine the structure and formation of mountains, than that of the sun or the stars.... we are not so overpowered by sublimity as in the contemplation of astronomy; we can think more calmly [sic] and reason more at ease; and we can trace the finger of God more visibly, perhaps, because more nearly” (Rennie 1828: 8–9). In particular, after a lengthy introduction to the “mineral geology” of Werner and Hutton, Rennie (1828: 45) prefaces his discussion of Penn’s model by calling it “no less ingenious than probable, and will give you much more sublime views of the creation than are to be found even in the inspired poem of Milton; and that is saying a great deal.”³ The children learn through the observation of rock samples from Mrs. R’s cabinet, but given the premise of the book (the theories of the history of the earth), there are no experiments conducted. This is a significant limitation of this work, and therefore it is difficult to classify this as a true example of the familiar format.

Another example of a work that does not fulfill the definition of the familiar format is the six-volume work *Scientific Dialogues* (1800–5), written by Reverend

³For a detailed analysis of Rennie’s style, see O’Connor (2007).

Jeremiah Joyce (1763–1816), the former tutor of the Earl of Stanhope's sons. Although written as a series of conversations, the teacher figures are both male (a male tutor and a father) while the students include two boys, Charles and James (named for the Earl of Stanhope's sons), and a girl, Emma. Joyce's work was extremely popular, enjoying seven editions from 1800 through 1892, one of its most famous readers being John Stuart Mill (Issitt 2002). In keeping with the multiple audiences targeted by such works, Joyce explained that

the whole work will be found a complete compendium of natural and experimental philosophy, not only adapted to the understanding of young people, but well calculated also to convey that kind of familiar instruction which is absolutely necessary before a person can attend public lectures in these branches of science with advantage. (Joyce 1852: i)

The work opens with a discussion between siblings, Charles and Emma, and their Father that gives direct credit to another famous series of children's stories:

Charles. Father you told sister Emma and me, that, after we had finished reading the "*Evenings at Home*," you would explain to us some of the principles of natural philosophy: will you begin this morning?

Father. Yes, I am quite at leisure.... These, I trust, will lead you insensibly to admit the wisdom and goodness by means of which the whole system of the universe is constructed and supported. (Joyce 1852: 1)

Note that the religious undercurrent of the work is present from the beginning, and is repeated throughout the work.

Emma is hesitant to begin the lesson, and, as is common in such works, voices a concern that she is too young to understand or appreciate science. She asks "can philosophy be comprehended by children so young as we are? I thought that it had been the business of men, and of old men too." Her father assures her that "Philosophy is a word which in its original sense signifies only a love or desire of wisdom; and you will not allow that you and your brother are too young to wish for knowledge" (Joyce 1852: 1). Joyce sets the tone for his approach to popularization in the same discussion, as Charles offers "But in some books of natural philosophy, which I have occasionally looked into, a number of new and uncommon words have perplexed me; I have also seen references to figures, by means of large letters and small, the use of which I did not comprehend." His father understands his son's concerns, offering

It is frequently a dangerous practice for young minds to dip into subjects before they are prepared, by some previous knowledge, to enter upon them; since it may create a distaste for the most interesting topics....The same sort of disgust will naturally be felt by persons who should attempt to read works of science before the leading terms are explained and understood. (Joyce 1852: 1–2)

Joyce then begins his lengthy examination of this topic by introducing the children to the concept of measuring and labeling angles, demystifying the topic at the start by deconstructing the very diagrams that Charles had voiced concern about.

In an interesting compromise experiment, English geology lecturer and mineralogical surveyor Robert Bakewell (1768–1843) attached to his lecture style *An Introduction to Mineralogy* a “Series of Conversations Explaining the Principles of the Science, and the Elements of Crystallography” (Bakewell 1819). In his introduction, Bakewell explains that “In the German method of describing minerals, the meaning is sometimes almost buried under a heap of terms” (1819: vi). As a result, he “adopted the form of dialogue in some of the introductory chapters of the present volume, that the student may become more familiar with the subject, by seeing it presented under different points of view, and may receive explanations and answers to certain queries and objections, that will naturally occur to his mind” (Bakewell 1819: vii). The conversation begins between two men, B, and F, who became separated during a hike because F was intrigued by sparkling crystals that he hoped were diamonds. B explains the true nature of the quartz crystals, which leads to a discussion of mineral properties. The style is very curt, a simple back and forth with few clues regarding the personalities of the two men or their relationship. This work in particular demonstrates the important difference between a mere conversation and a fully initiated familiar format work, especially in its lack of female authority figures.

One of the earliest popular examples of the true familiar format was *The Newtonian System of Philosophy; explained by familiar objects, in an entertaining manner; for the use of young ladies and gentlemen*, by Tom Telescope, the pen name of publisher John Newberry (1713–67), who played a pivotal role in the 1740s creation of the genre of books specifically for children (Fyfe 2003). Despite the fact that the subtitle claims that the work is appropriate for child readers of both genders, the active characters in the books are young boys, including the narrator, Tom Telescope, and several adult males. Several adult women (the wives of the male characters) do take part in the conversation, but are relegated to largely passive roles, something that is more prevalent in familiar format works written by men.

In this work, a series of schoolboys gathers over the holidays to play games at the home of Lady and Lord Twilight. But the young gentleman Tom takes the moral high ground, warning that

Playing at cards for money, says he, is so nearly allied to covetousness and cheating, that I abhor it.... I should prefer those which not only divert the mind, but improve the understanding: and such are many of the diversions at the school where I am placed. We often play at sham Orations, comical Disputes, measuring the Land and Houses, taking the Heights and Distance of Mountains and Steeples, solving Problems and Paradoxes on Orreries, Globes and Maps, and sometimes at Natural Philosophy.... (Telescope 1803: 2–3)

Mrs. Twilight is intrigued by this possibility of taking an active part in science (and in science as a type of play), and leads the children

to Mr. Setstar’s, that they might have the use of proper instruments. As Mr. Setstar was engaged in company, Lady Twilight, though nearly related to him, would not disturb him, but led them through the saloon [sic] into a private parlour, where our little Philosopher, at the request of her Ladyship, immediately opened the Lecture, without making idle excuses, or waiting for farther solicitations.... (Telescope 1803: 3)

Note the clearly domestic setting of the story in the parlor of the house, as described above. The remainder of the book is a set of conversations on various aspects of science, involving adults and children, always with an eye towards both experimentation and observation, but connecting the scientific concepts to everyday life. For example, in a discussion of minerals Tom explains “That reflecting telescope, this gold watch, and Lady Caroline’s diamond ear-rings, were all dug out of the earth; at least the materials were there found, of which these things are composed” (Telescope 1803: 88).

A second commercially popular early example of the familiar format was the work referenced in Joyce’s book, a series of stories entitled *Evenings at Home; or the Juvenile Budget Opened*. This collection was originally published in six volumes between 1792–6 (and reissued in various editions through the 1850s) by John Aikin and his sister Mrs. Anna Laetitia Barbauld.⁴ These stories involved the Fairbourne family who lived in the village of Beechgrove and entertained (and were entertained by) many visitors, always with an eye to improved morality. In order to contribute to the education of the Fairbourne children, these visitors would

frequently produce a fable, a story, or dialogue, adapted to the age and understanding of the young people.... and when the pieces were once read over, they were carefully deposited by Mrs. Fairborne in a box, of which she kept the key. None of these were allowed to be taken out again till all the children were assembled in the holidays. It was then made one of the evening amusements of the family to *rummage the budget*, as their phrase was. (Aikin and Barbauld 1819: 2)

Not only do both men and women, girls and boys, take part in the scientific investigations in this domestic setting, but as in the case of Tom Telescope’s investigations, hands-on experiential learning is stressed. For example, on the 21st evening, in a story entitled “On Earths and Stones,” Harry and George discuss with their tutor different types of “calcareous earth,” including marble, chalk, and limestone. The tutor directs George to pour vinegar on a “piece of chalk or an oyster-shell” on his own to see the effects of such minerals dissolving in acid (Aiken and Barbauld 1805: 8). *Evenings at Home* clearly meets the definition of a familiar format work, and sets an early standard that other works aspired to achieve.

Having surveyed some of the various examples of both the successful and incomplete application of the familiar format to writings in the physical sciences (and mainly by male writers), our attention now turns to early female writers in the genre. Both the works previously described and those highlighted in the following section largely formed the corpus of works to which those by Marcet, Hack, Lowry, Welsh, Godding, and Phelps would have been compared by both their readers and critics, as well as influential works from which these writers would have drawn their inspiration. These writers also demonstrated by example that such writing was, indeed, accepted by their society as proper for a lady, and that in some cases, women could support not only themselves, but their parents and/or children through science writing.

⁴For a detailed analysis of the works, see Levy (2006).

2.3 Early Women Authors of the Familiar Format

In her 1798 work *Reflections on the Present Condition of the Female Sex; with suggestions for its improvement*, Priscilla Wakefield opines “There are many branches of science, as well as useful occupations, in which women may employ their time and their talents, beneficially to themselves and to the community, without destroying the peculiar characteristic of their sex, or exceeding the most exact limits of modesty and decorum” (Wakefield 1798: 8–9). The writing of botany books, especially in the familiar format, for children and their mothers was one such occupation in the late eighteenth and early nineteenth century. As previously described, the genre incorporated a number of literary styles, from simple catechisms to letters and fully developed conversations. Shteir (1990) argues that the catechism was the least widely used of these formats by women science writers, perhaps because it was less personal and in its strictest form stressed memorization over contemplation. However, as will be shown, in the hands of some women writers even this normally restrictive form could serve the purpose of the familiar format. Letters were also less widely used than the conversation, although as Sam George (2011) notes, the epistolary form has a history of use in the writing of books meant to focus a young woman’s attention on proper ladylike behavior and societal norms (for example the conduct or advice book). It is now instructive to survey a sample of familiar format works written by women during the late eighteenth and early nineteenth centuries in order to illustrate both the common points of the content of the genre as well as the variety of ways in which it was executed by women writers.

Botany was the subject of the vast majority of familiar format works written by women between 1780 and 1830 for two important reasons. Firstly, the physical sciences were seen as a male bastion, and there were therefore far fewer women writers in these fields. Secondly, as noted by Lady Charlotte Murray (1754–1808) in her work *The British Garden* (1799), “The expensive apparatus of the Observatory, and the labours of Chemistry, confine the science of Astronomy, and the study of Minerals to a few.... But the study of Botany ... is open to almost every curious mind....” (Murray 1808: vi). One of the first women to take advantage of this role for science minded women was Maria Elizabeth Jacson (alternatively Jackson) (1755–1829). As was typical of the day, she anonymously published her works, *Botanical Dialogues: Between Hortensia and her Four Children* (1797), *Botanical Lectures* (1804), *Sketches of Physiology of Vegetable Life* (1811), and *Florist’s Manual, or Hints for the Construction of a Gay Flower-Garden, with Directions for Preventing the Depredations of Insects* (1816). Jacson was the daughter of Midlands rector Simon Jacson, who had received a clergyman’s education at St. John’s College, Cambridge. She and her older sister, Frances Margaretta (1754–1842), a novelist who, like Maria, never married, lived with their widowed father until his death in 1808 (Shteir 1990). Maria and Frances afterwards lived in Derbyshire with their elder brother Roger (1753–1826), but his second wife made the situation untenable, and they later settled in a manor house that had belonged to a maternal aunt (Percy 1997).

Jacson's first book, *Botanical Dialogues*, was, as its subtitle explains, a conversation between Hortensia and her children, Charles, Harriet, Juliette and Henry. Although the book was only attributed to *a Lady*, it contained within it a letter of support signed by two well-known figures, Erasmus Darwin (Charles Darwin's grandfather) and Brooke Boothby. It was their opinion of the text that "not only the youth of both sexes, but the adults also, will be much indebted to your ingenious labours" (Jacson 1797: iv). Jacson likely met Erasmus Darwin—well known doctor, scientist, and author of the long poem *The Botanic Garden*, as well as translator of Linnaeus, principal member of the Botanical Society of Litchfield, and enthusiastic proselytizer of Linnaean botany—through her cousin (on her mom's side) Sir Brooke Boothby (Shteir 1990). Darwin also recommended *Botanical Dialogues* as an effective textbook in his own *Plan for the Conduct of Female Education* (1797), a work meant for his daughters Susan and Mary Parker's girls' boarding school. Shteir (1990) interprets diary evidence to suggest that Jacson may have herself been friends with the Parker sisters.

In terms of its literary style, Jacson's dialogue is written in a rather script-like form, as shown:

Hortensia. . . . We will begin our lectures this morning. I have promised Henry and Juliette that they shall be of our parties, they are never idlers either at lessons or play, and will, I dare say, find both amusement and instruction from the study.

Henry. We will be very attentive.

Juliette. I long to know the names of all those pretty things, that we find when we pull a flower in pieces.

Hortensia. I am a little afraid, lest the hard names should be too difficult for my youngest pupils, however I will endeavour to make them easy. . . . (Jacson 1797: 3)

Note the acknowledgment of difficult scientific names, and the intention to simplify the topic for her young readers. However, Jacson is clear to delineate the limits to which she is willing to go in terms of simplifying the science:

Harriet. . . sometimes I feel a little afraid of being found dull; and I think I have heard of botanical books written for ladies, which make all the hard words easy.

Hortensia. There are some books, which pretend to do it; but the scientific terms are still to be learnt, and when learnt, in the language of those books, you cannot converse with a Linnaean botanist; they may make you a partial, but cannot make you an [sic] universal botanist. . . . (Jacson 1797: 71)

As previously noted, simplification does not necessarily mean the watering down of scientific terms.

Hortensia engages her children with the science through hands-on activities. For example, Jacson includes descriptions of observations of plants and their parts, and how to classify them, in addition to utilizing a microscope to examine them in more detail. Interestingly, when Hortensia introduces Charles and Henry to a more obscure type of plant, she explains to her sons "This tribe of plants not having been much attended to leaves to modern botanists an ample field of discovery, and I flatter myself it is reserved for you, Charles and Henry, to distinguish yourselves in it." When Charles asks why this knowledge is not also for his sisters, his mother explains

I do not doubt their abilities, and would have them as thoroughly informed upon the subjects that they study, as I wish you to be, but to avoid obtruding their knowledge upon the public. The world have agreed to condemn women to the exercise of their fingers, in preference to that of their heads; and a woman rarely does herself credit by coming forward as a literary character. The world improves, and consequently female education. Some years ago a lady was ashamed to spell with accuracy; happily the matter is now reversed, and the time will come, when it must be granted, that by improving our understandings, we enlarge our view of things in general; and thence are better qualified for the exercise of those domestic occupations, which we ought never to lose sight of, as our brightest ornament, when properly fulfilled. At this time information in a woman, beyond a certain degree, distinguishes her above her companions, and like all other distinctions is liable to lead her into a vain display, of what she hopes will gain her admiration.... (Jacson 1797: 238–9)

Shteir (1990) highlights the uncharacteristically sexist nature of this passage, and explains it as reflecting society's expectations for a proper lady of the time. A lady should be demure, modest, and certainly never provide intellectual competition for her husband.

There is also the obligatory connection between God and the natural world. As an example, Hortensia offers to her children concerning grains "We cannot contemplate the fruits of the earth, which are so bountifully bestowed on all climates, and the faculties with which man is endued to discover their uses, but we must adore in silent and grateful praise, the beneficent Creator of all things...." (Jacson 1797: 303). Unfortunately the book was not a commercial success and did not receive a second edition. Jacson afterwards abandoned the familiar format for a more straightforward and impersonal textbook style of writing in her later works.

Priscilla Wakefield (1750–1832) wrote over a dozen works, many in the familiar format. She was the eldest of six children in the Quaker household of Daniel Bell (1726–1802) and Catherine Barclay (1727–84), and in the tradition of her family's faith, she was educated at home by her mother. In turn she later played a role in the education of her own children and grandchildren, following her marriage to Edward Wakefield (1750–1826), a merchant (Leach 2006). Wakefield's Quaker faith and upbringing deeply shaped her convictions about the role of education for both boys and girls, including a basic understanding of science. This is reflected in her preface to *Mental Improvement, or the Beauties and Wonders of Nature and Art, in a series of instructive conversations* (1797). Wakefield believes there are "four methods of attaining knowledge. Observation, reading, conversation, and meditation. The first lies within the compass even of children, and from the early dawn of reason, they should be accustomed to observe every thing with attention, that falls under their notice" (Wakefield 1799: iii). This affords the "judicious instructor" with countless opportunities for developing "a lesson among, those objects, that are termed common or insignificant," but as she laments, these opportunities are not often taken advantage of, given the observed "ignorance, not of children only, but sometimes of youth, who, although they have attained a considerable degree of classical learning, are unacquainted either with the materials of those things they daily use, or the methods of manufacturing them" (Wakefield 1799: iii). In response, Wakefield takes care to integrate everyday items and experiences into her own instructional works, and encourages the direct, careful observation of these items.

Mental Improvement features the Harcourt family, two parents and their four children, ages nine to sixteen, who engage in evening lessons (many of which directly involving science) in their home. The children invite a friend, Augusta, to take part in their familiar lessons, taking pity on her because her mother is dead, an important moral lesson taught in the first pages of the book. Both parents take an active role in the instruction, on topics as varied as whales, telescopes, salt, honey, and wool. One evening Augusta apologizes for arriving too early for the lesson. Mr. Harcourt understands her eagerness to learn, and suggests that it is because of the pleasantness of the lessons offered. Wakefield then explains, through Mr. Harcourt, her personal pedagogical philosophy:

Instructions should always be rendered agreeable, in order to be beneficial to those that are to learn. The skill of a preceptor consists in gaining the affections of his pupils, and conveying knowledge in so gradual and clear a manner, as to adapt it to the strength of the young student's capacity. Many a poor child has been disgusted with books and learning, by the heavy laborious talks that have been given him to learn by heart, before he was capable of understanding them. (Wakefield 1799: 121)

Here we see an accusation still lobbed today at traditional passive modes of education, that the natural curiosity of children is dampened or even extinguished through rote memorization and boring lectures. To avoid this, Wakefield not only engages children in active learning, but introduces the content slowly and clearly (her mode of adaptation). Wakefield therefore fulfills all seven benchmarks of a work in the familiar format.

Wakefield wrote other works in this genre as well. For example, *Domestic Recreation; or Dialogues Illustrative of Natural and Scientific Subjects* (1805) features dialogues between Mrs. Dimsdale and her two daughters, Lucy and Emily. The family actively explores the natural world through personal observation. As the work begins, Lucy brings her mother an insect she has found and points out its “horns.” Her mother corrects her, naming them “antennae, or feelers” and proceeds to explain their presumed purpose (Wakefield 1805: 1). Emily offers, from her own personal experience, that a butterfly’s antennae are different, and Mrs. Dimsdale directs Emily to “take this key, and in my tortoiseshell cabinet you will find a drawer, in which there are the parts of many insects dried: bring it, and we will examine them” (Wakefield 1805: 2–3). Note that the Dimsdale family, like many of the families who would purchase Wakefield’s books, owns a natural history cabinet that can be utilized in the lessons.

Wakefield’s familiar format work in botany was *An Introduction to Botany, in a Series of Familiar Letters* (1796), framed as letters sent from one sister (Felicia) to another (Constance) during a period of separation. To pass the time and bridge the miles, Felicia explains that she will summarize her botany lessons for Constance in her letters, lessons arranged by their mother as they “will be beneficial to my health, as well as agreeable, by exciting me to use more air and exercise than I should do, without such a motive; because books should not be depended upon alone, recourse must be had to the natural specimens growing in fields and gardens” (Wakefield 1807: 2–3). As the letters are all from Felicia to Constance, the book reads more like a lecture than her conversational works, although they still include Felicia’s hands-on

observations of actual plants. Wakefield's intention for penning these letters mirrors the dual goals of education and religious inspiration so common in this genre:

The design of the following Introduction to Botany, is to cultivate a taste in young persons for the study of nature, which is the most familiar means of introducing suitable ideas of the attributes of the Divine Being, by exemplifying them in the order and harmony of the visible creation.... The structure of a feather or a flower is more likely to impress their minds with a just notion of Infinite Power and Wisdom, than the most profound discourses on such abstract subjects as are beyond the limits of their capacity to understand. (Wakefield 1807: iii-iv)

Wakefield also employs an epistolary framework in *An Introduction to the Natural History and Classification of Insects; in a Series of Familiar Letters* (1816) and *Excursions in North America, Described in Letters from a Gentleman and His Young Companion, to Their Friends in England* (1806).

Harriet Henrietta Beaufort (1778–1865) was born in Ireland, and found an interest in science, especially botany, through the influence and example of her father, Reverend Daniel Beaufort, a founding member of the Royal Irish Academy. An older brother, Francis (1774–1857), became a rear admiral in the Royal Navy and a cartographer and hydrographer, creating the Beaufort scale for wind force, while another, Reverend William (1771–1848) became Rector of Glanmere (Edgeworth 2010). Her sister Frances Anne (Fannie) (1769–1864) was the stepmother of writer Maria Edgeworth. Neither Harriet nor her sister Louisa (1781–1863) married. Their father became increasingly troubled by debt after relinquishing his clerical post in 1818, and Harriet and Louise turned to writing in part in order to support themselves and their father (Harvey and Ogilvie 2000). Both published anonymously, Louisa writing *Dialogues on Entomology* (1819) and Harriet *Dialogues on Botany* (1819). A difficulty with anonymously published books is that they are often ascribed to more well-known authors (as previously noted in the case of Rennie and Granville Penn). Such is the case with *Dialogues on Botany*, which is sometimes attributed to Maria Edgeworth. In her preface, Harriet argues that her mode of adaptation is, in fact, the very use of a dialogue format: “The familiar form of dialogue seems peculiarly suited to the taste of children; they identify themselves with the imaginary characters, and speedily acquire the habit of stating their difficulties and of asking for explanations” (Beaufort 1819: vi).

The work follows the lessons of three siblings, Fanny, Emma, and Cecil, as they are instructed by their aunt, Miss Mary Percival. Active learning is central to this work, for example, in the second chapter where the aunt meets her pupils in the garden (the domestic setting). The children are described as being eager to explore the structure of plants, “Cecil with his microscope, Fanny with pencil and memorandum book, and Emma with her knife well sharpened for the purpose of dissecting” (Beaufort 1819: 7). The author also employs a radical strategy for encouraging her readers to take part in hands-on learning, the omission of illustrations from her book. She defends this by stating that “experience has convinced the author that children should be induced to study nature, rather than engraved representations: every garden, field, and grove, will furnish them with examples; and the habits of examining the structure of real plants, and of seeing with their own eyes, will yield them not only more present pleasure, but far more certain and permanent knowledge” (Beaufort 1819: vi–vii).

A final example is the work of an author who is usually considered to have written in the familiar format genre, but in a style quite different from those discussed so far, Margaret Bryan (fl. 1815). Very little biographical information exists about Mrs. Bryan, so it is not known where her knowledge or independent approach to science writing might have originated. *The Dictionary of National Biography* identifies her as a “beautiful and talented schoolmistress” married to an equally mysterious Mr. Bryan and who taught at several different locations around London (Humphreys 1886: 154). She penned at least three physics and astronomy books for young readers, *A Compendious System of Astronomy in a Course of Familiar Lectures* (1797), *Lectures on Natural Philosophy* (1806), and *An Astronomical and Geographical Class Book for Schools* (1816). An engraving of Bryan and her two daughters appeared in the frontispiece of her first work and pictures her with her left hand resting on the base of a celestial globe, her writing quill in her right hand.⁵ Other scientific instruments are included in the picture, including a telescope. The illustration paints her as more than a passive transmitter of knowledge, and indeed Bryan’s writings demonstrate that she had considerable skill in the use of astronomical instruments. For example, an 1811 letter to William Herschel discusses her attempts to observe a comet that year (Brück 2009). In her *Lectures on Natural Philosophy* she describes her preparation for writing this book as “eight years’ study of the facts I have attempted to investigate, aided by seven years’ practical experience to establish these principles” (Bryan: 1806: x).

Bryan’s works were well-received by the scientific community, and *A Compendious System of Astronomy* included a letter of support from Charles Hutton, Professor of Mathematics at the Royal Military Academy, who had reviewed the manuscript and rejoiced that “the learned and more difficult Sciences are thus beginning to be successfully cultivated by the extraordinary and elegant talents of the female writers of the present day” (Bryan 1797: xi). The second (1799) edition of *A Compendious System of Astronomy* boasted a list of four hundred subscribers that included the Archbishop of Canterbury and the Secretary at War, as well as Reverend William Lax, Professor of Astronomy at Trinity College, Cambridge, and Reverend Dr. Nevil Maskelyne, the Astronomer Royal.

She explains in her preface to *A Compendious System of Astronomy* that “these Lectures were written for my pupils, and not originally designed for public inspection” (Bryan 1797: viii). This means that any adaptations that were made were meant for the benefit of her students alone, and were not initially meant for public consumption and critique. In particular, Bryan explains to her pupils/readers that the

study of mathematics would be misapplication of your time, which might be justly attributed to vanity and ostentation, and be considered unbecoming your character as females, by employing that time which is more usefully occupied in pursuits adapted to your situation in society, and as the validity of astronomical computation may be provided by those instruments I have provided, aided by your reason. (Bryan 1797: 103–4)

⁵A portrait based on the engraving is held by the National Portrait Gallery, London, and can be found at <http://www.npg.org.uk/collections/search/portrait/mw42469/Margaret-Bryan-with-her-daughters?>

But while Bryan might have not taught as much pure math as she might have if her pupils had been male, she apparently had no compunction in teaching applied mathematical techniques to these young ladies (utilizing, as she states above, various “instruments”). *A Compendious System* contains an appendix on the basics of trigonometry, an appendix explaining the mathematical tables found in a popular astronomical ephemeris, and set of trigonometric problems using the quadrant and compass, while *Lectures on Natural Philosophy* concludes with 111 solved astronomical and geographical problems using globes, followed by 20 pages of additional questions. Bryan was clearly setting the bar a bit higher for her own readership, and her books were not only read by a general audience, but were used as textbooks in both girls’ and boys’ schools.

Bryan’s literary style is quite different from most of the works considered so far. At first glance, she might be seen as lecturing to her audience, as noted in the title of her second book. However, her intended audience is clearly her female students, and she speaks to them in first person. For example, she dedicates *A Compendious System of Astronomy* to her students noting “Astronomy being the most important Science I have had the pleasure of introducing to your acquaintance, I think, by publishing my Lectures on that subject, I shall afford you a pleasing retrospect of the sublime ideas it conveys.” She refers to herself as “the friend who delivered” these lectures, and notes “to be forgotten by you, would inflict a severe pang on that heart which feels for you almost parental tenderness” (Bryan 1797: iii–iv). In her creation of a conversational tone, the one-sided nature of her dialogue with her pupils is therefore no less befitting of the familiar format label than Harriet Beaufort’s epistolary works.

Theological considerations are seamlessly integrated with scientific facts and observations, as is customary in such works. The contemplation of astronomy, in particular, is amenable to such lessons, but it is not only in the celestial that such wonders are to be found. For as Bryan offers,

whether we soar in contemplation of the majesty and glory of God displayed in the Heavens, or pursue our scrutiny of the wonders and benevolence of his administration and dispensations, manifested in the organization and effects of things upon Earth, still we discover new cause for congratulation, new sources of delight and adoration. (Bryan 1797: 162)

Moral lessons also play a central role in her work, as is common in this genre. *A Compendious System of Astronomy* concludes with the admonition

I hope with advantage, by planting the infant shoots of that harmonious uniformity, benevolence, and order, you therein observed—and that you will cultivate the impressions you have received, so as to bring forth the fruits of those virtues, let your situation in this sublunary state be what it may, even ever so obscure.... Thus, in all situations, you will find virtue to be your best friend, the most likely to make you happy in yourselves, and loved and respected by the world. (Bryan 1797: 233–4)

Likewise she opens her *Lectures on Natural Philosophy* with an “Address to my pupils,” where she explains her purpose for writing this book as to prevent her lessons from fading from her pupils’ minds, “arming you with a perpetual talisman, which, your conduct justifying its power, will secure you from all pernicious doc-

trines, and guard your religious and moral principles against all innovations” (Bryan 1806: iv). Bryan also stresses her own dual roles, those of a good Christian teacher and surrogate mother, to her students:

Happy indeed am I, in the good effects my precepts have produced on many whom I have had the pleasure of instructing: and on none are these impressions more distinguishable than on my own dear children; in whose strict piety, candid integrity and dutiful affection, I rejoice most exceedingly, and feel more blessed than language can express. That the Almighty may continue to direct my dear children and pupils by his spirit—establish them in the performance of their duty by his aid—and endow them with constancy in bearing the afflictions of human life, is my most ardent supplication! Impressed with this hope and animated by the tenderest affection—I rejoice in the titles of Parent and Preceptress. (Bryan 1806: vi–vii)

Despite her strict adherence to the expected moral and ethical conventions of her day, Margaret Bryan was forward-thinking in a number of ways. Not only was she a woman teaching other women in a field that was decidedly male, but she educated her students for not only a single moment, but in her desire for them to return to her lessons, for a lifetime. In this way Bryan sought to instill an appreciation for lifelong learning in her students, who she considered as dear to her as her own children. Having explored these examples, we now turn our attention to the bulk of the book, a close examination of the lives and works of six women who wrote books in the familiar format in the geological sciences, and situate their work against writings of the same period by women who elected not to use this format for their own work.

References

- Aikin J, Barbauld AL (1805) *Evenings at home; or, the juvenile budget opened*, vol 5, 6th edn. Johnson, London
- Aikin J, Barbauld AL (1819) *Evenings at home; or the juvenile budget opened*, vol 1, 12th edn. Baldwin, Cradock, and Joy, London
- Bakewell R (1819) *An introduction to mineralogy*. Longman, Hurst, Rees et al, London
- Beaufort H (1819) *Dialogues on botany, for the use of young persons*. Hunter, London
- Bensaude-Vincent B (2009) A historical perspective on science and its ‘others’. *Isis* 100:359–368
- Bratton B (2013) We need to talk about Ted. <https://www.theguardian.com/commentisfree/2013/dec/30/we-need-to-talk-about-ted>. Accessed 15 Mar 2017
- Brück MT (2009) *Women in early British and Irish astronomy*. Springer, Dordrecht
- Bryan M (1797) *A compendious system of astronomy, in a course of familiar lectures*. Leigh and Sotheby, London
- Bryan M (1806) *Lectures on natural philosophy*. Davison, London
- Cooter R, Pumphrey S (1994) Separate spheres and public places: reflections on the history of science popularisation and science in popular culture. *Hist Sci* 32:237–267
- Ellison K (2004) Science and celebrity. *Front Ecol Environ* 2(9):504
- Fyfe A (2003) Science for children. In: Fyfe A (ed) *Science for children*, vol 1. Thoemmes Continuum, Bristol, pp xi–xxii

- Fyfe A (2008) Tracts, classics and brands: science for children in the nineteenth century. In: Briggs J, Butts D, Grenby MO (eds) *Popular children's literature in Britain*. Ashgate, Hampshire, pp 209–228
- Gates BT (1998) *Kindred nature: Victorian and Edwardian women embrace the living world*. Chicago UP, Chicago
- Gavroglu K (2012) Science popularization, hegemonic ideology and commercialized science. *J Hist Sci Technol* 6:85–99
- George S (2011) Epistolary exchange: the familiar letter and the female botanist, 1760–1820. *J Lit Sci* 4(1):12–29
- Godding DW (1847) *First lessons in geology*. Parsons, Hartford
- Harvey J, Ogilvie M (2000) *The biographical dictionary of women in science*, vol 1. Routledge, New York
- Hilgartner S (1990) The dominant view of popularization: conceptual problems, political uses. *Soc Stud Sci* 20:519–539
- Humphreys J (1886) Bryan, Margaret. In: Stephen L (ed) *Dictionary of national biography*, vol 7. MacMillan, New York
- Issitt JR (2002) Jeremiah Joyce: science educationist. *Endeavour* 26(3):98
- Jacson ME (1797) *Botanical dialogues, between Hortensia and her four children*. Johnson, London
- Joyce J (1852) *Scientific dialogues: intended for the instruction and entertainment of young people*. Knight and Son, London
- Kohlstedt SG (1990) Parlors, primers, and public schooling: education for science in nineteenth-century America. *Isis* 81(3):424–445
- Larsen K (2014) Margaret Bryan and Jane Marcet: Making space for 'space' in British women's science writing. In: Narain M, Gevirtz K (eds) *Gender and space in British Literature, 1660–1820*. Ashgate, Farnham, pp 67–82
- Leach C (2006) Religion and rationality: Quaker women and science education 1790–1850. *Hist Educ* 35(1):69–90
- Leane E (2017) A brief history of Stephen Hawking's blockbuster. *Nature* 541:28–29. doi:[10.1038/nature16881](https://doi.org/10.1038/nature16881)
- Levy M (2006) The radical education of Evenings at Home. *Eighteenth-Century Fiction* 19(1):123–150
- Lightman B (2007) Historians, popularizers, and the Victorian scene. In: Lightman B (ed) *Victorian popularizers of science: designing nature for new audiences*. Chicago UP, Chicago, pp 1–38
- Lowry D (1822) *Conversations on mineralogy*. Hunt, Philadelphia
- Lyell KM (ed) (1881) *Life, letters, and journals of Sir Charles Lyell*. Murray, London
- Marcet J (1817) *Conversations on chemistry*, vol 1, 5th edn. Longman, Hurst, Rees et al, London
- Murray CM (1808) *The British garden*, vol 1, 3rd edn. Wilson, London
- O'Connor R (2007) Young-earth creationists in early 19th-century Britain? towards a reassessment of 'scriptural geology'. *Hist Sci* 45:357–403
- O'Connor R (2013) *Earth on show: fossils and the poetics of science 1802–1856*. Chicago UP, Chicago
- Percy J (1997) An unrecognized novelist: Frances Jacson (1754–1842). *Br Libr J* 23(1):81–97
- Rennie J (1828) *Conversations on geology*. Maunder, London
- Shteir AB (1990) Botanical dialogues: Maria Jacson and women's popular science writing in England. *Eighteenth-Century Studies* 23(3):301–317
- Shteir AB (1996) *Cultivating women, cultivating science*. Johns Hopkins UP, Baltimore
- Shteir AB (1997) Elegant recreations? configuring science writing for women. In: Lightman B (ed) *Victorian science in context*. Chicago UP, Chicago, pp 236–255
- Telescope T (1803) *The Newtonian system of philosophy*. Johnson, Philadelphia
- Wakefield P (1798) *Reflections on the present condition of the female sex; with suggestions for its improvement*. Johnson, London
- Wakefield P (1799) *Mental improvement, or the beauties and wonders of nature and art*, 1st edn. Greene and Sons, New Bedford

- Wakefield P (1805) *Domestic recreation; or dialogues illustrative of natural and scientific subjects*. Darton and Harvey, London
- Wakefield P (1807) *An introduction to botany, in a series of familiar letters*, 5th edn. Darton and Harvey, London
- Whitley R (1985) Knowledge producers and knowledge acquirers: popularisation as a relation between scientific fields and their publics. In: Shinn T, Whitley R (eds) *Expository science: forms and functions of popularisation*. Reidel, Dordrecht, pp 3–28

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