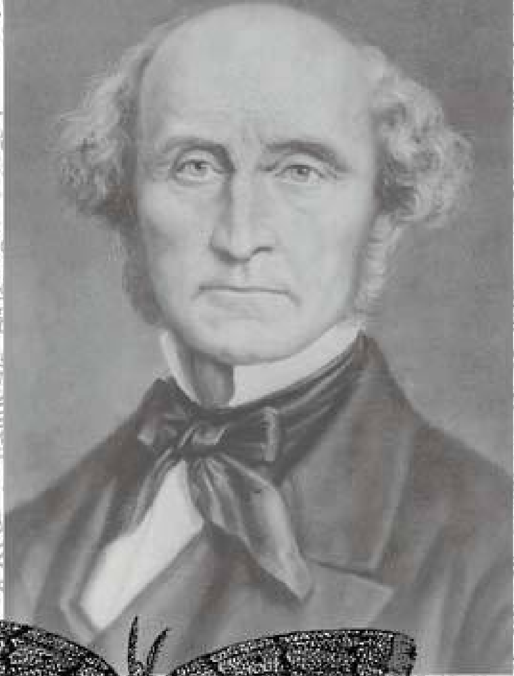

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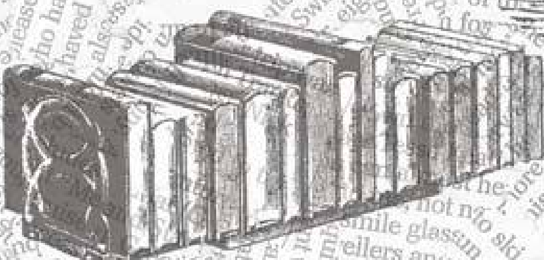

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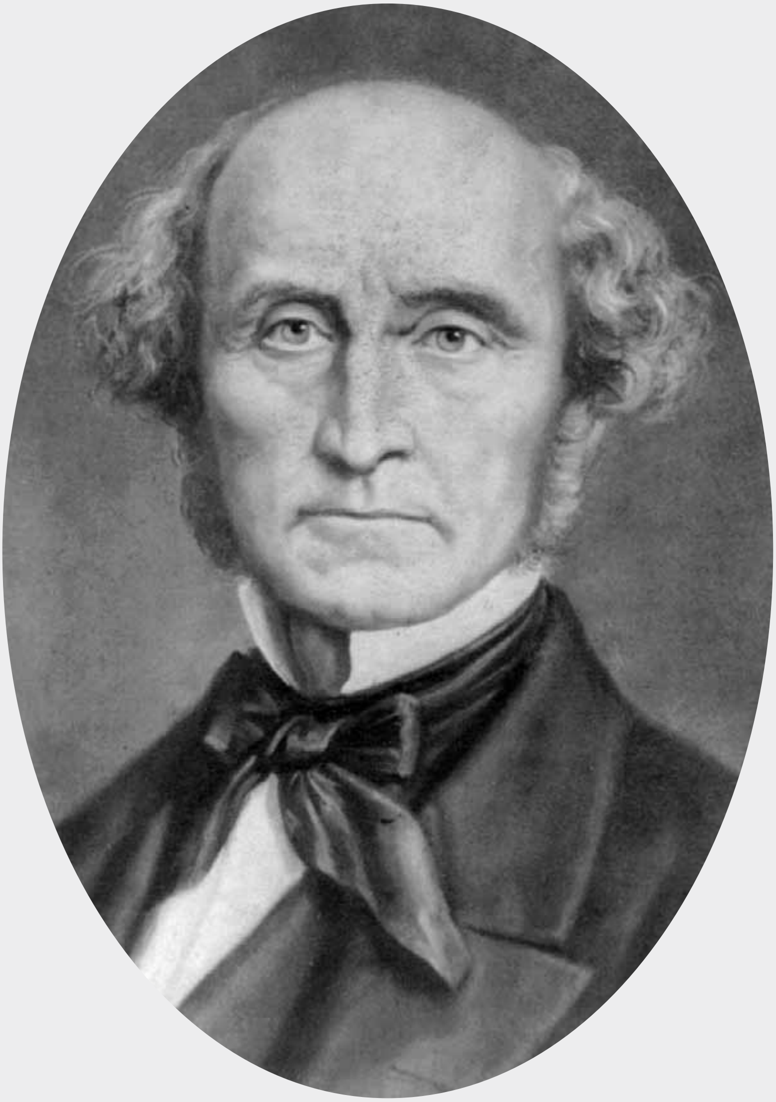

John Stuart Mill

20 May 1806 – 8 May 1873

Photograph of John Stuart Mill. Courtesy of the Library of Congress, LC-99068-050-BF33B0EB.

Introduction

HISTORICALLY, EDUCATION HAS BEEN EXCLUDED FROM THE DOMAIN OF science. John Stuart Mill might well have changed the boundary lines when he wrote A System of Logic (1843). This classic work articulated five inductive methods for logically selecting and arranging sets of example so they would make clear what caused what. Ironically, Mill indicated that his methods did not apply to education — which he regarded as an art — although he observed that they did apply to "imparting our knowledge to others."

If would have taken a very small step for him to conclude that his methods must apply to education because education is the business of imparting our knowledge to others. If he had taken that small step, the history of education most probably would have changed greatly because education would have been admitted to the domain of science. The probable result would have been that much of the polemic and ineffectiveness that characterize today's instructional practices would have been preempted by scientific procedures and logic for developing effective instruction.

This book compares what actually occurred since publication of A System of Logic with some of the more probable scenarios of what could have happened if education had been framed as a science that resides on a logical-empirical base.

A haunting question that underpins the scenarios is why Mill didn't acknowledge that his system of logic could apply to instruction. The answer Mill expressed was simply that "Education" was an art, not a science, and education retained this status in his analysis, which means he apparently did not recognize that education could have a scientific base (p. 5). He may have been influenced by tradition. At the time he wrote, formal instruction was not designed to include all children, only the intellectual elite who clearly had potential to succeed academically. In this context there was no compelling need for effective instruction, simply smart, motivated students. Another possible reason is that Mill was so focused on the goal of establishing a new kind of logic that could serve science, he didn't see the implications of his principles for instruction. In any case, Mill excluded education from his scheme.

❑ Chapters 1 and 2 recap Mill's five principles of induction and their rediscovery in the 1970s by the authors, Engelmann and Carnine.

❑ Chapter 3 develops the inferences about the learner's mind that are implied by Mill's principles. The mind is depicted as being perfectly logical.

❑ Chapter 4 focuses on possible changes that might have occurred in the early twentieth century under the influence that Mill's orientation would have had on John Dewey, John Watson, and later behaviorists.

❑ Chapter 5 centers around discovery-learning practices in which students are not explicitly taught procedures or relationships but are expected to figure them out without assistance. and how Mill's educational stance might have altered the endorsements of discovery practices and theories, particularly Jerome Bruner's conceptions of effective instruction and instructional theory.

❑ Chapter 6 provides an application of the logico-empirical approach to shape details of an instructional sequence. Logical principles dictate how the sequence is designed. Empirical tests determine whether all learners have learned what the sequence is designed to teach.

❑ Chapter 7 identifies the broad categories of casualties that result from the current nonscientific orientation of instruction. People in all areas of education, from critics to participants, are victims of not understanding what could be achieved with well-designed instruction.

How Children Learn

A basic truth that derives from Mill's methods is that all learners learn inferences that are consistent with the examples that are presented. If the examples presented to teach something are capable of generating only one inference or meaning, that is what all learners will learn, regardless of other differences among individual learners. Some learn faster; some slower; some have more interest in learning; still others may not have the prerequisite skills necessary to learn what is being taught. If learners have these skills, however, and attend to the examples and what the teacher says, all will learn the same thing from the example set.

If the examples presented generate more than one meaning, not all learners will learn the same thing; however, all will learn something that is consistent with the examples presented. Let's say the teacher demonstrated the meaning of a made-up word, glerm, by waving a green cloth vigorously and saying, "This is glerm." If no other examples are presented, glerm could mean a lot of things — waving something, a piece of green cloth, waving something green, waving a cloth, and so forth. If we probed to identify what children thought glerm meant, we would discover that virtually all identify something consistent with the example the teacher presented. They wouldn't say that glerm means something not consistent with the example, say an elephant, or cooking something.

Children's understanding of glerm changes as they receive more information. If the teacher first waves the green cloth and says, "This is glerm," then stops waving, and as she holds still says, "This is not glerm," the possible meanings would be reduced. Now glerm could mean waving something, waving something green, and other possible meanings consistent with the examples, but glerm could not mean green or cloth because the example was a green cloth when it was waving and when it was stationary. If the teacher presents further examples to rule out all possible meanings but one, all children will learn that meaning.

Mill's methods are concerned with drawing scientific inferences about what caused what, so how could they apply to instruction? For the instructional extension, children must play the game of figuring out "What caused the teacher to label things the way she did?" For example, "What caused the teacher to say 'this is glerm' sometimes, and 'this is not glerm' other times?" To identify the possible causes is to identify the unique properties shared by all examples of glerm. Because Mill's methods provide basic rubrics for presenting sets of examples that generate only one inference about what causes what, they apply to instruction.

The kind of reasoning required for children to learn such causal relationships is often complicated, but the evidence clearly shows that children's minds are wired to draw inferences consistent with the example sets. The job of teaching effectively, therefore, involves figuring out efficient ways to design, order, and sequence example sets so that they are consistent with Mill's logic, and so that the instruction provides sufficient practice for children to retain and become facile with what is taught.

The issue of practice does not derive from logical analysis, but from empirical evidence. Nor do effective procedures for reinforcing children when they respond correctly derive from logic. We discover if something reinforces behavior only by observing the extent to which it results in an increase in that behavior. We discover how much practice is required for children to learn something by documenting the amount of practice they need.

So the formula for teaching things effectively necessarily involves two separate analyses, the logical analysis, à la Mill, and an empirical analysis. The logical analysis provides the constraints for the designer to develop an instructional program that seems adequate; however, the logical analysis cannot reveal whether instruction provides a sufficient amount of practice. The empirical analysis takes the form of field tests, which provide the final word about how effective the program is. Observations of children's responses disclose which sequences or activities are not as effective as the designer had assumed, and which discriminations require more practice than the program provided.

Observations about which details children tend not to learn logically imply how specific instructional sequences must be designed (using procedures consistent with Mill's methods). The analysis of the problem discloses whether the designer had failed to teach a discrimination or skill that was needed in the learning sequence. Once the missing element is identified, the logical analysis implies how to arrange examples to teach it correctly. Together, the two analyses in the logico-empirical approach shape the details until the instructional program is highly effective for the intended student population.

Philosophical Orientation

Could John Stuart Mill Have Saved Our Schools? is not concerned with how students acquire knowledge in a broad sense, but only with procedures for transmitting specific knowledge and how to apply it. In other words, the work is not really concerned with unbounded "learning," but only with the type of learning that is caused by teaching. Certainly there is some overlap in issues related to learning and to teaching. However, the logico-empirical analysis does not address variables that lie outside those that teachers can control — variables such as human nature, gender differences, or how differences in interests affect what individuals learn.

The process of causing children to learn specific content is quite sensitive to the differences in children, but only from an instructional standpoint. If a student does not have the prerequisite skills needed to learn specific content, the student must be placed in a program that first teaches the missing skills.

Could John Stuart Mill Have Saved Our Schools? is aligned with aspects of several philosophical orientations, but it is not aligned with all details of any orientation. For example, we share the idea of empiricists that children enter the world with no public knowledge and that everything students learn comes from experience. However, our concern is not with the blank-slate considerations raised by Stephen Pinker (2002), for instance, such as why the slate is not actually blank because it is biased by human nature. From a teaching standpoint, the assumption is that if students have specific skills and knowledge, we can treat related skills and knowledge as areas of the blank slate, which means that we can cause specific "writing" to fill those blank areas. And if it doesn't happen, we assume that the failure is not a result of a flawed slate, but a result of the methods we used to write on it.

In the same way, our orientation is consistent with aspects of greatly different philosophical orientations, such as platonic realism. In a nonmystical way, the present analysis assumes there are abstract forms that are never viewed as a whole but that may be taught. For instance, we teach a naïve learner the color blue. We do that by presenting concrete examples of things that are blue and things that are not blue. Whether the learner has learned the form is revealed only through the learner's response to examples that are implied by the form.

When the instruction is completed, we assume that the learner has knowledge of a form (blue) that goes beyond the specific examples we have taught However, the only way we can confirm the assumption is by observing how the learner responds in concrete instances. If she is able to correctly identify examples of blue that were not presented during the teaching, we confirm that this learner has a mental conception that goes beyond the individual examples we have directly taught. If she is further able to correctly identify an example of blue she has never experienced before, we receive confirmation that the learner has internalized the abstract form of blue.

This inference is not mystical because the only way the learner could perform this mental feat would be to use a model that is consistent with what was taught. This model properly integrates the specific examples that were taught into a coherent form that also includes possible examples that were never experienced. Indeed it is remarkable that children are able to perform such sophisticated form construction, but that ability is part of the data processing mechanism that children inherit. This mechanism is not taught, simply directed and focused on different content.

The logico-empirical analysis is also consistent with aspects of pragmatic orientations, such as those of Charles Peirce (1868) and William James (1907). Pragmatists believe that any conception in the mind has to be manifested in a behavior. Or, from a practical standpoint, if a mental conception cannot be revealed by some behavioral manifestation, how do we know it is understood? James related an experience that illustrated the problem of assuming that students learned something without observing their responses to specific applications. He observed students being taught the sentence, "The interior of the earth is in a state of igneous fusion." When he asked the students how the temperature of the earth would change as you dug a hole deeper and deeper, they couldn't produce responses that suggested they understood the practical effects of the sentence. By contrast, because the logico-empirical approach addresses the construction of example sets that generate only a single inference, the students' responses to various examples provide the teacher with strong evidence of the children's understanding.

The logico-empirical analysis has particularly close ties to the behavioral conception of B. F. Skinner (1953). However, the analysis restricts application of behavioral principles to issues that are not logical, but behavioral. Creating a set of examples that generates only one inference requires applying logical principles, not behavioral principles. Furthermore, if a sequence is logically flawed, it supports the prediction that some children will learn unintended inferences. This prediction is based on logic, not behavioral principles. Certainly it is confirmed by observations of behavior, which is the basic role of the behavioral analysis in the logico-empirical analysis. Other applications of behavioral principles involve the use of reinforcement in shaping student attention, fluency, memory, and interest.

Perspective

We tried to write this book so it would be understandable to people who were not in the field of education — particularly people who appreciate scientific reasoning. Historically, educators have not appreciated how logic and scientific methods are capable of creating great differences in what students learn; however, extensive research evidence documents the effectiveness of the logico-empirical analysis, especially with hard-to-teach populations.

Appendix A, Studies Based on Unique Assertions of Theory of Instruction, lists over 50 studies that address specific predictions based on the logico-empirical analysis, and studies involving programs for teaching reading, math, spelling, and other content designed in accordance with the analysis. Several studies involve large numbers of subjects, including the evaluation of Project Follow Through, the largest educational experiment ever conducted.

CHAPTER 1

Mill's Foundation

IF THE HISTORY OF PHILOSOPHY HAD GONE IN A SLIGHTLY DIFFERENT direction, our educational system today would be scientific rather than haphazard, and would have a strong focus on causing learning to happen, not on treating learning as a byproduct of vaguely described experiences or a correlation that tells little about what actually causes a specific behavior. A scientifically based education system would use practices that have been documented to work, and would have an ethical underpinning parallel to the one in medicine that insists on using techniques that are effective and not harmful.

In retrospect, the critical point at which the history of education took a pronounced wrong turn was in the mid-nineteenth century, after the publication of a work by John Stuart Mill, the last of the great British empiricist philosophers. This work was A System of Logic (1843).

Although unrecognized at the time, this foundational work provided the technical premises needed to design effective instruction.)

The Empiricists

All British empiricists shared the same premise — that all knowledge arises from experience. So their central concern was to describe how this happens. How do we know that something we have never seen before is blue, has corners, and has a handle? How do we know that the sun will come up in the east and that trees will grow, even when we don't see them growing? How do we know that any triangle has interior angles of 180 degrees and that A + B equals B + A, but A – B does not equal B – A?

The first of the English empiricists was John Locke (1632–1704) who introduced the notion of the tabula rasa, the blank slate, which Locke assumed a baby possessed at birth — a mind that was blank and had no knowledge. The slate was then written on by experiences, which came in the form of sensations.

Descartes (a non-empiricist) and others challenged this notion, and a back-and-forth duel occurred over the following two centuries between a succession of non-empiricists and a corresponding succession of British empiricists, who formulated new theories that responded to the apparent flaw in the theories of their predecessors.

One of the later British empiricists, George Berkeley (1685–1753), used God as a mediator to preserve those things that are true but transcend experience.

Berkeley's successor was the most extreme empiricist, David Hume. His position acknowledged that all knowledge derived ultimately from sensation, but he divided knowledge or reasoning into categories. These, and the overall tenor of his position, are neatly summarized in the closing paragraph of Hume's most famous work, An Enquiry Concerning Human Understanding (1748). The quotation also shows his response to Berkeley.

> If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion. (p. 107)

Aside from the fact that it was a pretty risky assault for the 1700s, when people were still being burned at the stake for disputing the existence of God, the quote identifies Hume's categories of reasoning — the use of facts about the world and the kind of deductive reasoning used in math and science.

The biggest problem with Hume's extreme position was that he didn't have the theoretical provisions needed to address the process of how facts are acquired. For his conception of math, the reasoning was deductive, which means that there are rules or laws. Each may be applied to a particular concrete situation, which leads to a specific solution, such as the number 2031. So this reasoning goes in the direction of general to concrete-specific.

But learning facts about the world doesn't go in that direction. Nobody first learns rules about objects that are to be identified as being automobiles and then learns to apply this rule. Rather, young children learn that their family car is called a car and their next-door neighbor's car is called a car. For example, a young child points to a car and is able to generalize, "Look, Daddy, car." Sometimes this application of a homespun rule is correct, but sometimes it isn't. "Look, Mommy, big car."

"No Honey, that's a truck."

"Ruck?"

"Yes, truck. Truck."

And another cycle begins.

This process of going from concrete instances to the formulation of a general rule is called induction. This is the process for learning all facts about the world. Sometimes, the learning is aided by a verbal mnemonic, definition, or rule, but these are quite different from mathematical rules because the objects used in math — the numbers and signs — don't have many features, but every example of a car, a truck, or the street they drive on each has thousands of features.

"Look, Honey. The truck has many wheels, and look how big it is. Cars are much smaller than trucks."

"Trucks big?"

"Yes, trucks are very big."

An actual definition of a truck that could even come close to providing exhaustive visual information about a truck would require pages of very small print.

Hume's theory had no provisions for people to learn through induction, so basically, the theory had no realistic mechanism for learning facts. For Hume one had to experience something and that sensation was what was registered in the mind, nothing more. Furthermore, there were no provisions for expanding it or tying it to other sensations. Hume believed that people could imagine things like a yellow dragon through the simple act of combining the "sensation" of yellow with the "sensation" of dragon. Also, in a footnote, Hume acknowledged that a person would be able to identify a shade of blue that the person had never experienced, but he wrote this off as a singular and unimportant exception.

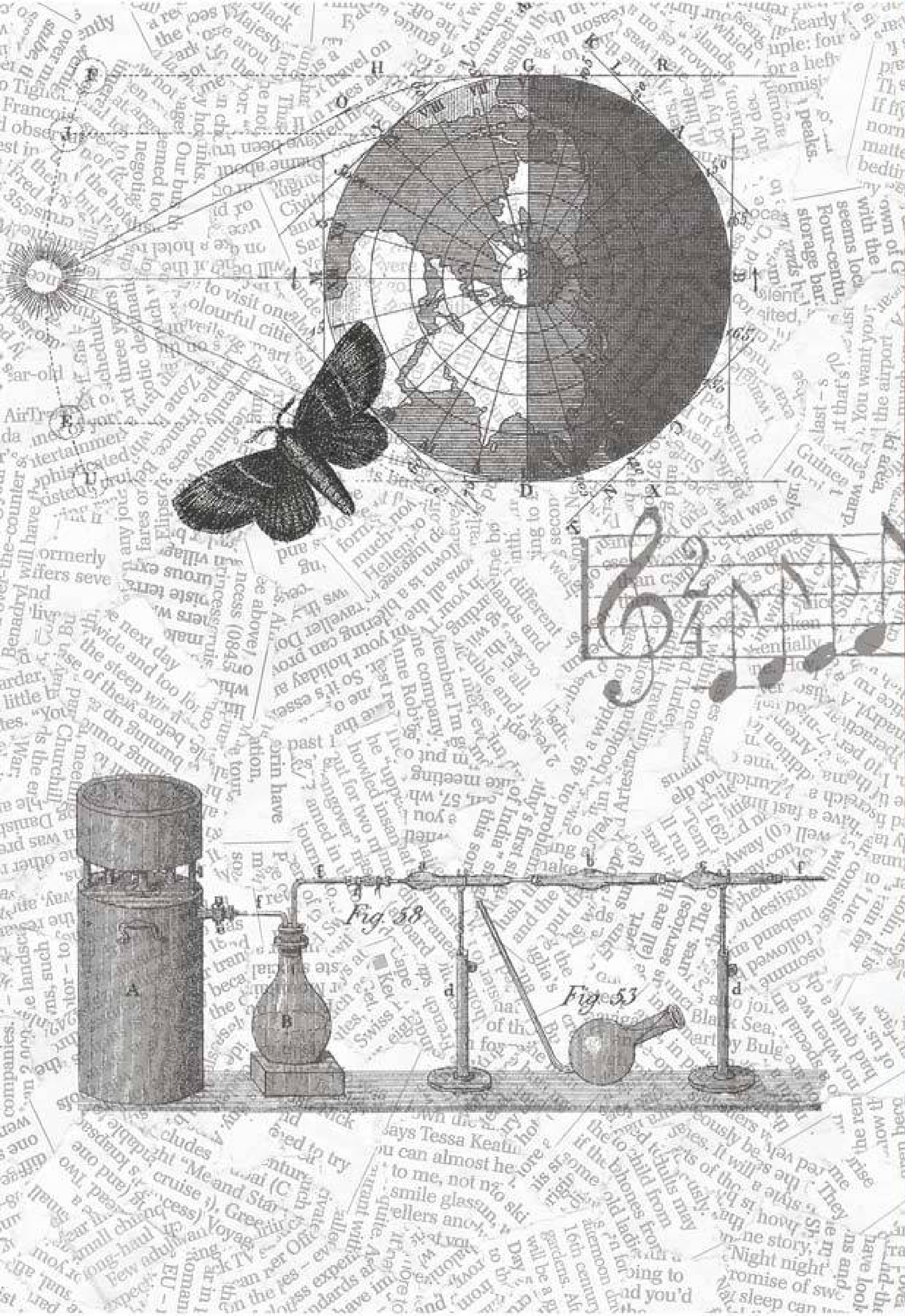
Fig. 53