Answering Huxley: “now” students take a “then” exam

P. K. Rangachari

Bachelor of Health Sciences (Honors) Program, Faculty of Health Sciences, McMaster University, Hamilton, Ontario, Canada

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Rangachari PK. Answering Huxley: “now” students take a “then” exam. Adv Physiol Educ 43: 397–400, 2019; doi:10.1152/advan.00079.2019.—Twenty-eight undergraduate students in a health sciences program volunteered for an exercise in the history of examinations. They had completed a second-year course in anatomy and physiology in which they studied modern texts and took standard contemporary exams. For this historical “experiment,” students studied selected chapters from two 19th century physiology texts (by Foster M. A Textbook of Physiology, 1895; and Broussais FJV. A Treatise on Physiology Applied to Pathology, 1828). They then took a 1-h-long exam in which they answered two essay-type questions set by Thomas Henry Huxley for second-year medical students at the University of London in 1853 and 1857. These were selected from a question bank provided by Dr. P. Mazumdar (University of Toronto). A questionnaire probed their contrasting experiences. Many wrote thoughtful, reflective comments on the exercise, which not only gave them an insight into the difficulties faced by students in the past, but also proved to be a valuable learning experience (average score: 8.6 ± 1.6 SD).

INTRODUCTION

“The past is a foreign country: they do things differently there” (6). Then and now often differ sharply, so considering the “then” may help better understand the “now.” Twenty-eight students in an undergraduate health sciences program had an opportunity to contrast the textbooks read and the examinations taken by medical students in the 19th century. They took part in an exercise that sought to answer a single question: How would students who were successful in passing modern examinations respond to an older 19th century examination format? They were asked to read chapters from 19th century physiology textbooks and answer two questions set for second-year medical students at the University of London. This exercise arose out of casual conversations I had with several students while we were exploring the contrasting perspectives of students and teachers on the matter of examinations in general (10).

A pilot study with a few students led to a slightly larger study. I contacted a number of other students who I knew were interested in educational issues. Many of them were undergraduate teaching assistants in different courses. All of them had taken earlier courses in cellular and molecular biology, as well as anatomy and physiology. This was important, as the questions I was going to give them were taken from physiology examinations given to medical students in the years 1857 and 1859. The examiner who set the questions was Thomas Henry Huxley.

Many students these days vaguely remember Huxley as the great defender of Darwin (his “bulldog”) and promoter of evolutionist ideas. However, he was an excellent scientist in his own right (1, 2). He survived a dysfunctional childhood, had little formal schooling, but taught himself by voracious reading. He was fortunate to get a free scholarship to attend Charing Cross Hospital Medical School in London. He completed the nonclinical component (winning prizes in chemistry, anatomy, and physiology), but never finished his degree and joined the Royal Navy to earn his living. Much like Darwin on the Beagle, Huxley found himself on an ocean-going ship, in his case, a cockroach-infested frigate, H.M.S. Rattlesnake. However, that experience proved invaluable for, as a naturalist, he was able to gather many different organisms from the ocean using an adapted wire-mesh meat cover. He studied these carefully, his reports about these very delicate creatures attracted much attention, and he acquired a reputation as an outstanding naturalist. When he returned to England, his reputation had been solidified, and he was soon elected a Fellow of the Royal Society—a tremendous achievement and a testimony to his self-directed, inquiry-based learning. Later, he contributed much to natural history, paleontology, and science education. Since he did not come from a wealthy family like other Victorian scientists (Darwin, Lyell, and others), he had to cobble together income from a variety of sources. His influence as a teacher and scientific organizer was extensive, both in Britain and elsewhere. He played a major role in the British Association for the Advancement of Science, the Royal Society of London, the Royal Institution of Great Britain, and various learned societies. He was a member of Royal Commissions (e.g., on Scientific Instruction and the Advancement of Science, and on Fisheries), and served as a member of the first London School Board, 1870–72. He pushed for teaching more science at all levels, implemented the use of laboratory instruction, and was not only an excellent teacher, but also a celebrated public speaker. He had an excellent international reputation and was an invited speaker at the opening of the Johns Hopkins University in Baltimore in 1876.

Huxley wrote extensively on educational issues and gave numerous speeches to diverse audiences. Although he had only completed the first part of the medical program (his highest academic qualification), he was appointed an examiner

Address for reprint requests and other correspondence: P. K. Rangachari, Bachelor of Health Sciences (Honors) Program, McMaster University, 1280 Main St. W, MDCL-3308, Hamilton, Ontario, Canada L8S 4K1 (e-mail: chari@mcmaster.ca).
in physiology and comparative anatomy as well as zoology and 11-degree examinations in the Faculties of Arts, Medicine and Science from 1856 to 1870 (1). He felt particularly strongly about physiology and noted that:

A thorough study of Human Physiology is, in itself, an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots, or its branches, do not extend; like the Atlantic between the Old and the New Worlds, its waves wash the shores of the two worlds of matter and of mind; its tributary streams flow from both (2).

He also noted that it was “a comparatively easy matter to learn anatomy and teach it; it is a very difficult matter to learn physiology and teach it” (9).

In his letters and speeches, Huxley had discussed his attitude to examinations in general. In one of his speeches (8), he noted that he had considerable experience as an examiner at multiple levels from elementary schools to fellowships at universities, but he held that they were “a necessary evil” and “like fire, is a good servant, but a bad master.” He went on to note that students “become deteroriated by the constant effort to pass or that examination” so that they “work to pass, not to know; and outraged Science takes her revenge. They do pass, and they don’t know.”

He noted that, although he himself had passed lots of examinations, he was “ashamed to think how very little real knowledge underlay the torrent of stuff” that he was able to pour out on paper (8). He felt that such examinations, as ordinarily conducted, test “simply a man’s power of work under stimulus, and his capacity for rapidly and clearly producing that which, for the time, he has got into his mind.” He went on to say that, “under the best of circumstances, I believe that examination will remain but an imperfect test of knowledge, and a still more imperfect test of capacity, while it tells next to nothing about a man’s power as an investigator” (8).

Nevertheless, he served as an examiner for a number of years, and many of his letters to Michael Foster (4), in particular, mention his attempts to get more examiners, since there were large numbers of students.

I tried to simulate the earlier conditions by giving students chapters from two 19th century textbooks (see METHODS). The examination itself consisted of just a set of two essay-type questions prepared by Huxley. I emphasized to the students that I was interested in their perceptions and their responses to the exercise, and they need not concern themselves with the answers themselves. I did not want them to worry unduly about the quality of the answers they would give. Knowing the students though, I knew that they would not take this exercise casually.

By the mid-19th century, the written examination had become the norm in major English universities. The earlier reliance on oral exams in public spaces had been replaced by all candidates giving individual answers to identical, written questions in a secluded room to enable examiners to gauge the uniformity of work done under standard conditions. One reason for this shift from oral to written examinations was the larger numbers who needed to be accommodated (7, 11).

METHODS

Students

Twenty-eight students volunteered to take part in this exercise. All were in their third or fourth year of a Bachelor of Health Sciences (Hons) Programme at McMaster University. They had taken two half-term courses in anatomy and physiology, where they read modern texts and were assessed using standard multiple-choice questions (MCQs) and timed-practical exams (bell-ringers).

Process

Students were told that they had to read specific sections from late 19th century texts and be prepared to take a 1-h-long written exam. The questions they would answer were those set by Thomas Henry Huxley for medical students at the University of London. They were specifically told that the important element would be for them to go through the experience, and that their answers to the questions will be read but not graded. The material provided for them were sections from two 19th century texts. The material from A Textbook of Physiology by Sir Michael Foster (5) dealt with the properties of blood (book I, chap. I, Blood, p. 15–45), and another was on the properties and characters of bile, pancreatic juice, and succus entericus, as well as the formation of the constituents of bile (book II, chap. I, sect. 3. The properties of bile, pancreatic juice and succus entericus, p. 354–360; chap. IV, sect. 3. The formation of the constituents of bile, p. 584–588). The material from A Treatise on Physiology Applied to Pathology by Broussais (3) dealt with the circulation of the blood (chap. VII, Of the circulation of the blood, p. 360–393). Students were given several weeks to read the material. An excerpt from Foster’s book is shown in Fig. 1. as an example of the material the students were expected to read.

The examination itself was held in a quiet room. Students were not permitted to bring any ancillary material and were told that their answers in standard lined answer booklets. They were given two questions:

1. Describe the secreting structure of the liver. Give an account of the composition and uses of the bile, and state what is known of the clotting of the blood.

SEC. 1. THE CLOTTING OF THE BLOOD.

§ 14. Blood, when shed from the blood vessels of a living body, is perfectly fluid. In a short time it becomes viscid: it flows less readily from vessel to vessel. The viscosity increases rapidly until the whole mass of blood under observation becomes a complete jelly. The vessel into which it has been shed can at this stage be inverted without a drop of the blood being split. The jelly is of the same bulk as the previously fluid blood, and if carefully shaken out will present a complete mould of the interior of the vessel. If the blood in this jelly stage be left untouched in a glass vessel, a few drops of an almost colourless fluid soon make their appearance on the surface of the jelly. Increasing in number, and running together, the drops after a while form a superficial layer of pale straw-coloured fluid. Later on, similar layers of the same fluid are seen at the sides and finally at the bottom of the jelly, which, shrunk to a smaller size and of firmer consistancy, now forms a clot or crassamentum, floating in a perfectly fluid serum. The shrinking and condensation of the clot, and the corresponding increase of the serum, continue for some time. The upper surface of the clot is generally slightly concave. A portion of the clot examined under the microscope is seen to consist of a felwork of fine granular fibrils, in the meshes of which are entangled the red and white corpuscles of the blood. In the serum nothing can be seen but a few stray corpuscles, chiefly white. The fibrils are composed of a substance called fibrin. Hence we may speak of the clot as consisting of fibrin and corpuscles; and the act of clotting is obviously a substitution for the plasma of fibrin and serum, followed by a separation of the fibrin and corpuscles from the serum.

Fig. 1. Excerpt from Foster’s textbook (part of the material given to students to study) (5).
the changes produced in the composition of the blood during its passage through the portal circulation.

2. What is meant by the coagulation of blood? Describe the changes that accompany that process and the conditions that accelerate or retard it?

Both questions formed part of examinations taken by second-year medical students at London University. The first question was answered by students who took the exam on Monday, November 3, 1857, and the second by students on Monday, November 1, 1859. Those students had 3 h to answer six such questions. The McMaster students were given 1 h for the two questions.

After the exam, all students filled out a questionnaire in which they were given seven statements and asked to indicate the strength of agreement on a 10-point scale (1 strongly disagree to 10 strongly agree). Space was given for comments as well. The statements and the scores given are tabulated (Table 1).

RESULTS AND DISCUSSION

The experience (Table 1) had considerable learning value, as indicated by the average score of 8.6 (SD 1.6). Opinions varied concerning some of the other elements. These are discussed below.

Comparison of Textbooks (Then and Now)

A number of students felt that the texts were dense (four specifically commented on this aspect), and the absence of diagrams added to the difficulty. Others noted that “our material is very dumbed down” and “modern texts simplify too much” or are actually “convoluted.” One student noted that the 19th century books “promoted a deeper understanding, forced to independently construct a mental image.” Another noted that they understood concepts, text written as a novel, whereas current books were “more matter-of-fact.” In the excerpt shown in Fig. 1, Foster’s description of coagulation is very visual. They also noted that the authors provided experimental rationale, and that these books were better for self-directed learning.

Another commented that, apart from occasional differences in language, the text was easy to read. Some students recognized the greater resources available to them now and felt that they have it much easier. On the whole, this component of the exercise clearly provided a rich learning experience.

Table 1. Summary data on Huxley exam

| Items                        | Mean | Median | Mode | Range |
|------------------------------|------|--------|------|-------|
| 1. Textual material (19th century) | 6.8  | 7      | 8    | 3–10  |
| 2. Absence diagrams          | 8.4  | 8      | 10   | 2–10  |
| 3. Modern texts              | 7.9  | 8      | 8    | 5–10  |
| 4. Questions clarity         | 7.0  | 7      | 10   | 3–10  |
| 5. Questions difficulty level| 6.2  | 7      | 8    | 1–10  |
| 6. Insight into past difficulties | 8.1  | 8      | 9    | 4–10  |
| 7. Value for learning        | 8.6  | 9      | 10   | 6–10  |

Data were collected from 28 students. Students were given a series of statements and asked to indicate the strength of agreement on a 10-point scale (1, strongly disagree, to 10, strongly agree). Space was given for comments as well. The statements were as follows: 1) the textual material provided [chapters from Foster (5) and Broussais (3)] was dense and difficult to read; 2) the absence of diagrams in the material provided made it more difficult to understand the material; 3) modern texts make it easier to understand complex concepts; 4) the questions provided were simple and clear; 5) the questions posed by Huxley were more difficult to answer than the ones we are given in our courses; 6) the exercise gave us an insight into the difficulties faced by past students in studying anatomy/physiology; and 7) the exercise provided a valuable learning experience.

Questions (then and now). The central issue that was explored was the capacity of the students to cope with the questions posed. There was a greater variation in the scores given. Although 12 students gave scores in the 8–10 range, there were one-half that number who gave scores in the 3–4 range. They commented that, although the questions were clear, the open-ended nature would make it difficult for the student. Several commented that this sort of exam was “a better test of understanding,” and would “require in-depth understanding,” and a student had the opportunity “to display all my learning and understanding.” Several compared this approach to the MCQ format, which they found wanting: “better method than MCQ.” “MCQs allows students to pass evaluations easily because you are given the answers, all you have to do is recognize which one is correct from the choices provided,” “MCQs much easier, just recognize a list,” and “do not allow opportunity to formulate connections between concepts.” Another noted that the older approach challenges “the student to fully understand the concepts so that they can coherently explain in writing,” whereas, in modern exams, the “focus is on memorising small details, rather than fully comprehending the overall process and its importance.” Also, the Huxley exam required students to pay greater attention to language.

Learning experience. The exercise itself was useful in that regard (24 of the 28 students gave scores in the 8–10 range). They appreciated the opportunity, got not only a deeper appreciation for the sheer variety of resources available to the modern student, but also for the level of understanding demanded of the earlier student. One comment was that “modern day exams are much easier to do well with a more limited understanding of relevant concepts.” It is important to emphasize that all of the students who took part had received high grades (≥90%) in high school and continued to have grade point averages in the 3.8–4 range. So, they showed considerable insight into recognizing the frailty of an approach that had served them so well.

I had promised the students not to consider the answers themselves, since I wanted them to focus on the experience itself. The answers were variable, partly because these students were not used to writing such exams and also because they could not entirely forget what they had already learned, so certain anachronisms crept in.

It would have been interesting to see what Huxley himself would have made of the answers. I have mentioned earlier that he was well aware of the limitations of the examination approach to trusting student capabilities. He did, however, take his duties seriously and, in many of his letters to Foster (4), mentions the efforts made to recruit examiners. He was probably not an easy marker. He mentioned that he had “a bad reputation among students for setting up a very high standard of acquirement.” The knowledge he sought for in students “was a real, precise, thorough, and practical knowledge of fundamentals” but got instead in a large number of cases, “a large, extensive, and inaccurate knowledge of superstructure” (9). Ironically, modern examinations may in fact encourage students to dwell on a large number of details and make it difficult for them to focus on the fundamentals. In a letter he wrote to Michael Foster in May 1870, he makes the following comment, “You did quite right in plucking all these fellows. I left off a few that you were doubtful about—but the great
majority are slain” (4). Huxley uses the old-fashioned English word “plucked” for failing a student.

This study had obvious limitations. The sample size was small; the few students were not randomly selected and represented a carefully selected group. Nevertheless, their experiences do highlight some of the clear differences in resources available and assessment practices, then and now. It was also heartening that these students who were so successful with modern grading practices could clearly identify the strengths of the older approaches. There is a more subtle limitation. This exercise remained partial at best. The students answered 19th century questions in a classroom with all modern comforts, whereas those who answered Huxley, did so perhaps under less comfortable conditions (ill lit, draughty rooms, and using pens dipped in ink). It is impossible to recapture those intangibles. More importantly for the Health Sciences students, the consequences of giving poor answers were relatively slight. The tension present in the presumably draughty examination halls in the early spring of the 1850s can only be imagined, never really felt.

In this context, one of my students made an interesting comment that it was “scary to have 1.5 years’ worth of education come down to a mere six questions.” That struck home to me. Clearly MCQs or short-answer exams can sample a larger domain. The last formal examination I took in medical physiology was in December 1962. I had to answer 10 questions based on material learned over 1.5 yr, in two separate papers. The build-up to that major exam (the preclinical phase) had been tough. A month earlier, the country was at war, and we had to endure black-outs and air-raid sirens through the preparation period. The possibility that exams could be canceled was real. Fortunately, it all subsided a few weeks before the exams begin. My internal examiner was an eminent physiologist, who a few years later joined the likes of Huxley and became a Fellow of the Royal Society, London. He made no concessions. The exam itself was tough, and we all barely survived! Yet, in an odd way, the tension, the preparation, and the uncertainties added a unique flavor, providing for me the most exhilarating phase of my entire medical education. The past is a foreign country—things were different there and then.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

P.K.R. conceived and designed research; performed experiments; analyzed data; interpreted results of experiments; prepared figure; drafted manuscript; edited and revised manuscript; approved final version of manuscript.

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