

PHYSICS FOR THE ENQUIRING MIND: THE NUFFIELD PHYSICS ORDINARY  
LEVEL COURSE, 1962-1966

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The Nuffield Physics curriculum project has a strong claim to have been the first national curriculum project held in the UK, with significant social and political implications. Yet there has been very little research on this project since its introduction over half a century ago. This chapter reviews the experience of the Ordinary level General Certificate of Education (O-level GCE) project in its development stage of 1962-1966. It does so in particular by investigating the transnational dimensions as opposed to the national basis of the project, involving its personal and ideological connections with the United States.

The key role of the project organiser, Eric Rogers, was based on these transnational connections. His ideal of physics for the enquiring mind, developed in a widely influential text, was based on his transatlantic experiences. These were manifested first in his early career travelling in the United States and communicating with John Haden Badley, the veteran headmaster of the progressive independent school, Bedales School, in England. They were highlighted also in his interactions when he was based at Princeton University in the US with the local team of Nuffield Physics, while he was its organiser during its development phase.

## **1. Introduction**

The Nuffield Foundation Science Teaching Project (NFSTP) marked the beginning of a concerted phase of curriculum reform in Britain in the 1960s, reflecting the high

hopes for educational and curriculum change, and more broadly for social change, that were widely held during that decade. It represented modernisation in a new age of science dominated by the atom bomb and the space race. In many ways it was, at least initially, an elite project, strongly influenced in the British context by the elite independent schools, and confined largely to the 20 to 25 percent of pupils in grammar and independent schools who were able to take the O-level examination at the age of sixteen.<sup>1</sup> As such, it was perhaps overshadowed by the egalitarian reforms of the 1960s such as progressive education in the primary schools, comprehensive secondary education, the Schools Council curriculum reforms of the later 1960s, and polytechnics and the Open University in higher education.<sup>2</sup>

Nuffield O-level physics was the first project to be developed under the NFSTP, and perhaps the most innovative and interesting. It addressed an issue that has remained an important policy concern in subsequent decades, that is, how to excite and enthuse pupils about physics. Nuffield physics aimed to achieve this through encouraging pupils to conduct their own experiments, and to think as far as possible like scientists, rather than by learning facts. In essence, this approach can be traced back to the Greek philosopher Archimedes and his famous cry 'Eureka' – 'I have found it!'. Yet it has received little historical attention. Unlike Nuffield O-level chemistry, which was the focus of Mary Waring's significant study published in 1979, Nuffield O-level physics in particular still awaits detailed historical treatment.<sup>3</sup>

In the 1960s, it could be suggested that Nuffield Science was 'conceived on New Education lines', and that it demonstrated that 'progressive methods are working their way into the schools'.<sup>4</sup> The Safari project at the University of East Anglia pointed out that the 'Nuffield Approach' was not simply about 'a particular technique for teaching science', but rather 'relates to a whole complex of meanings which have

connotations which stretch into history and biography, as well as into the wider psychological, social and moral facets of human action'.<sup>5</sup> In the early twenty-first century, this historical, biographical and social lineage has been all but forgotten. Even Roy Lowe's excellent history of progressive education does not clearly recognise this link.<sup>6</sup> Thus, it has been asserted that progressivism in English schools is a 'lost legacy'.<sup>7</sup> A deeper examination of the hidden ancestry of Nuffield physics suggests another story, and a different verdict.

The research that has been published on Nuffield Science has generally traced its national development in relation to changes in education, politics and society within Britain. In this sense it has followed the dominant historiographical trend of British school science education, which has been national in its focus rather than transnational or even international. The classic work of Michael Argles in the 1960s, followed in later decades by writers such as David Layton, Edgar Jenkins and Brian Woolnough, was largely national in its approach rather than seeking to emphasise the international context and still less the influences that ran in different directions across national borders.<sup>8</sup>

The history of science education in Britain, and the history of Nuffield Science itself, has also tended to lack a strong biographical or life history dimension, in understanding the ways in which science teachers and educators developed during their careers. There were many teachers whose lives and careers helped to shape and were in turn shaped by Nuffield Science, in their schooling, teacher training, teaching, and later work in the field. Such personal and professional links can forge a direct connection between different initiatives over a lifetime. One example of this was Gordon van Praagh (1909-2003), who was inspired by the 'heuristic' or guided discovery methods pioneered in the 19<sup>th</sup> century by H. E. Armstrong, both at school

and in his teacher training, before becoming a chemistry teacher and later being appointed as a member of the headquarters team for Nuffield chemistry in the early 1960s.<sup>9</sup> In his published memoir, van Praagh himself traced significant links between Armstrong, Nuffield and the National Curriculum that was introduced in the late 1980s that together provide an important contribution to our understanding of these developments.<sup>10</sup>

The transnational dimension can be closely linked to the biographical aspect. Recent work has included research on the marketing of the Dalton Plan in Great Britain in the 1920s; Sue Middleton's study of correspondence between Bloomsbury, London and New Zealand for the New Education Fellowship in the 1930s and 1940s; and Elsa Estreda's exploration of the personal dimension in curriculum policies in Portugal since the 1960s.<sup>11</sup> In the case of Nuffield Science, teachers and educators who began their careers in the 1930s will often have retired by the 1970s, and in this period channels of transport and communication over long distances were transformed. In the interwar years of the 1920s and 1930s, international travel was mainly by ferry or ships which might take weeks, or by the hazards of early air flights. Air mail letters were at their historical peak volume, but took several days or longer to reach their intended recipient. The telephone remained unreliable and difficult to coordinate. By the 1960s and 1970s, the telex and telegram were more effective means of written communication within a much shorter period, while the telephone and air travel had become standard and effective international links. Email communication and personal computer technology remained unknown for another generation, but the changes by the mid to late 20<sup>th</sup> century were already immense, and helped to reshape the nature of transnational connections within the span of a professional lifetime.

For the Nuffield physics O-level project, the key figure was undoubtedly Eric Rogers (1902-1990). Rogers was educated at the progressive and coeducational boarding school Bedales in Hampshire from 1916 to 1921, before going on to study at Trinity College Cambridge. He gained first class honours in Mathematics and Natural Science and was then appointed as physics master and assistant house master at Clifton College, Bristol, from 1925 to 1928. He returned to Bedales as a physics teacher in 1928, but left in 1930, eloping before the end of summer term with a history teacher at the school, Janet Drummond, whom he married in the US later that year. For the next two years he was a tutor and instructor at Harvard College, a post that allowed him to visit schools and study developments in physics education in the US, returning to England to take up a physics post at Charterhouse school from 1932 to 1937. He then went back to the US, as assistant head at the Putney School, Vermont, until 1940, with appointments following at Mount Holyoke College and then St Paul's Concorde, before becoming associate professor of physics at Princeton University, New Jersey, in 1941. At Princeton, he was to become a professor of physics and remained for thirty years until he retired in 1971.<sup>12</sup>

In the late 1950s, Rogers became a member of the Physical Science Study Committee (PSSC) which took the lead in reforming school physics education, stimulated by the shock created by the Soviet Sputnik satellite in 1957.<sup>13</sup> He also prepared what became his best known work Physics for the Inquiring Mind (1960), followed in 1962 by Teaching Physics for the Inquiring Mind.<sup>14</sup> His principal ideas were rehearsed in these works. In particular, he expressed his antipathy towards the effects of traditional science courses. He argued that children were naturally drawn to science: 'Young people are thrilled with the idea of scientific experiments and knowledge. Many a small boy is eager to learn physics and chemistry. When we

show him a plain test tube, his tongue hangs out with enthusiasm. He longs to play with the first magnet he sees.’ Yet such enthusiasm was deadened by a few years of science courses: ‘A few emerge still determined to be scientists – but even they usually have a strange picture of science as a set of stamp-collections of facts, or else a game of getting the right answer. For the majority, well-meant teaching has built a wall around science, a stupid antagonistic wall of ignorance and prejudice.’<sup>15</sup>

Rogers insisted that science courses should show what science is like, what scientific procedure was like, and what scientists were like. Experiments were central to this, but so was theory, which played a complementary role.

The different parts of a science course should also be clearly linked together in Rogers’ view, which posed challenges for textbooks, laboratory work, and examinations alike: ‘Ideally, laboratory work should be the student’s own investigation of nature, not a well explained, clearly exercise on the chapter of the week. When we find these learning aids falling far short of the ideal, we must put our trust in two strong human influences: the student’s wish to learn science as a whole – a wish that can be suggested and encouraged – and the skill of every good teacher as an active guide towards connected knowledge.’<sup>16</sup> His ideals, forcefully expressed, provided the central basis for the transnational connections underlying Nuffield O-level physics in its formative years.

## **2. From Bedales to Harvard**

During his initial sojourn in the US while at Harvard in 1930-32, Rogers conducted a correspondence with the head of his old school, Bedales, keeping him up to date with his plans and reflecting on his experiences. The form of this correspondence was as significant as the content. For the most part, he wrote long letters by airmail,

often very long letters written in two or more stages over a period of time that took several days to arrive. These provided in some cases detailed notes on his visits to schools and in other instances lengthy and thoughtful reflections on his ideas and travels. These letters suggest that the initial source of his inspiration for teaching and for curriculum change came from Badley, Bedales and interwar progressive boarding schools. Equally, they show him comparing the nature and quality of education in general and the physics curriculum in particular in England and the United States, and clearly weighing up the problems and advantages of each and assessing potential ways forward.

Bedales School was well known for the strength of its progressive ideals. The first teaching appointment of its headmaster, Badley, was at the newly opened independent school Abbotsholme in 1889, under Cecil Reddie. In 1893, Badley left to found Bedales as a coeducational school, and it was for the principle of the coeducation of boys and girls that Bedales became best known. Like Abbotsholme, Bedales cultivated a broad curriculum with a strong community ethos unlike the strict classical curriculum espoused by the traditional independent schools. In the early 1930s, Badley was towards the end of his long tenure as headmaster of Bedales, and he retired in 1935.<sup>17</sup>

The time taken over Rogers' airmail correspondence with Badley is clear throughout. In an early letter, in October 1930, Rogers resolves to 'post the beginning now, and continue it really soon – spurred on by all the good intentions which I have been storing up for some time'.<sup>18</sup> Another letter at the start of 1931 notes that he had looked forward to writing but, 'It was meant to begin the New Year – so it looks as if I should begin my New Year in February.'<sup>19</sup> Another is declared to have 'waited long enough – it has spent the last week in my handbag, waiting for spare moments'.<sup>20</sup>

The letters themselves reflect Rogers' affection for his old school and headmaster, and reveal the source of his reforming zeal and idealistic passion. He addressed Badley as 'Dear Chief', and repeatedly emphasised his nostalgia for Bedales, where, as he recalls, 'changes are tried, not merely talked of'.<sup>21</sup> He yearned for the 'jostling happiness' of Bedales, while realising 'how very far ahead Bedales is'.<sup>22</sup> Indeed, he lamented, 'I often feel very homesick for Bedales, and I long more and more to get back to something that I call real school life.'<sup>23</sup> He was interested in some experimental initiatives in the US, such as for example at Rollins college in Florida (which took 26 hours to reach by rail travel from his base in Boston).<sup>24</sup> He was also impressed by some of the 'progressive' schools in New York, especially in the younger classes. The Dalton schools in particular caught his attention for their use of projects under the Dalton plan, and more broadly for their school buildings and furnishings.<sup>25</sup>

On the other hand, he was highly critical at some of the common features of education in the US, especially the emphasis on examinations and the poor standard of the courses and teachers. Rogers commented that 'Added to the difficulty of finding good staff, is the burden of the universal use of marks, both to the universal use of marks, and to their progress and to register final "grades", which, it seems, end the study of a subject and sanction its carefree dismissal to a remote memory.' He added that 'the evil here lies in the attitude of being satisfied with knowledge accumulated, examined, dismissed – a museum disease (in which one journey through the museum is insufficient)'.<sup>26</sup> He soon became impatient with the mechanical system of mass education in the US, as he complained: 'People here are crazy about tables of numbers and facts, and it is pitiful to find them applying their methods undiluted to a living thing like a school.'<sup>27</sup> Even the best progressive



schools, he lamented, were 'run by cheerful visionaries who talk too much and let their school run on with a standard of teaching that seems hopeless', while for older students 'the other schools drum in facts (and a worship of temporary fact acquisition) in a way that smells of old text-books with wood engravings'.<sup>28</sup> He preferred to be with 'experts to teach specialised subjects' rather than teaching large groups of children of an average standard 'as a mere bread-and-butter thing' such as was the custom in American high schools, and to be 'where people are happy, learning to live, not merely learning verbs or trying to pass exams'.<sup>29</sup>

These ideas also influenced his approach to teaching physics. He observed that physics teaching was concentrated almost entirely on the entrance to university, 'either dreary or taught by very raw people; with practically no good experimental work'. This dull style of physics teaching he found to be repeated when students took a physics course on entering university, 'which does little more than repeat this drudgery – yet with very fine lecture experiments, and real teachers giving the courses'.<sup>30</sup> At Harvard, he was given some of the lecturing and an almost autonomous role in reorganising a general course in physics for those who had studied physics at school but would do no more after this, and welcomed the opportunity 'in eliminating more logical substructure, and building up instead some idea of scientific ideas and aims, and methods'.<sup>31</sup>

Thus, for Rogers' restless energy, the opportunities seemed to be in teaching small groups of students with an academic grounding at high school or university, although he was also frustrated by the structures of examinations and rote learning that he found at these higher levels of education. He soon realised that it would be better to return to England, although he was increasingly conscious of the economic difficulties affecting education on both sides of the Atlantic, and that he would much

prefer to return to a new-style independent school such as Bedales rather than a traditional one. Having failed in his efforts to return to Bedales, he looked at other similar progressive independent schools, settling in the end on Charterhouse school, and returned to England in 1933.

These early experiences and travels between Britain and the US appear to have done much to establish the ideals and ambitions of the young Eric Rogers. Bedales was the crucible for an educational career in which his reforming instincts came to the fore in his chosen subject, physics.

### **3. From Princeton to Nuffield Physics**

By the 1950s, Rogers was at the peak of his distinguished career as professor of physics at Princeton University. The wider context had changed greatly since his earlier sojourn in the US, but some aspects remained recognisably the same. In Britain, the spread of secondary education to the whole age range had in many ways entrenched the position of academic grammar schools within a system of different types of school, while the independent schools, struggling in the 1930s and during the Second World War, had regained much of their former dominance. In both Britain and the US, the school curriculum remained much as it had been in the interwar years, while the wider society continued to change. Internationally a 'Cold War' had developed in which the US and the Soviet Union were ideologically opposed protagonists, with the atom bomb and the emerging 'space race' key features of a global contest.

In the US, one initiative created to help modernise the school science curriculum and respond to these new challenges was the Physical Science Study Committee (PSSC), established at Massachusetts Institute of Technology in 1956. The

following year, the National Science Foundation granted the PSSC 245,000 dollars in aid to support its work to facilitate curriculum change at the high school level, with an emphasis on the most able pupils. The 'spirit of enquiry' underlying the PSSC's sources was very much in the line of Rogers' Physics for the Enquiring Mind, and indeed Rogers himself was a member of the PSSC. Josep Simon has found that the PSSC was transnational in nature, with many leading PSSC staff travelling to different countries and being exposed to a range of national cultures.<sup>32</sup> Rogers brought his earlier transnational experiences into play for the benefit of the project, and also shared his insights to support fresh initiatives in Britain.

The PSSC and other US ventures also attracted attention from Britain, and in late 1960 R.A.R. Tricker of the Ministry of Education visited the US, covering over 6,000 miles, to find out about new trends in science teaching. In his report on his visit he emphasised that the new courses being designed were suited to the particular organisation of schools in the US: 'It is most unlikely that we would wish to adopt this pattern for ourselves; we would wish for any changes which may be necessary to evolve from our own traditions.'<sup>33</sup> It also seemed to him unlikely that school science in Britain would develop a similar reliance on indirect teaching through films and television, or adopt American courses as 'packages' for use as they stood. At the same time, he argued that American text books, teaching films and apparatus might well be helpful in the British context. He also recommended what he saw as the 'spirit of enquiry', rather than the 'performance of exercises', that underlay these new courses. Tricker was especially interested in the laboratory apparatus designed by the PSSC and developed as kits available for schools at low prices. As he noted, 'The design of much of the apparatus is original and ingenious. That for dynamics is delightful. The timing device made from the movement of an electric bell and paper

tape for use with small trolleys mounted on roller skate wheels, the “hover craft” vehicles using dry ice and moving practically without friction over a sheet of plate glass and the stroboscopic camera are excellent examples.’<sup>34</sup>

The Ministry of Education in Britain had resisted intervening actively in curriculum matters, but by the late 1950s there was increasing interest among a number of groups in the possibility of curriculum change, with the science curriculum a clear priority. The science teachers’ associations, the Advisory Council on Scientific Policy and the newly created Minister for Science (Lord Hailsham) supported an initiative put forward by the Nuffield Foundation. The NF initially set aside £250,000 for the revision of O-level science courses, and the Nuffield Foundation Science Teaching Project (NFSTP) was launched formally with the support of the Government in April 1962. The Nuffield project in O-level physics was the first to be organised, but its first organiser, Donald McGill, suddenly died in March 1963. Eric Rogers had been enlisted as an adviser to the project, and he was now invited to take over as its organiser.

There had been many international events and visits that had helped shape the ideas underlying the Nuffield O-level project, besides Tricker’s visit to the US. As early as 1956, Henry Boulind of the Science Masters’ Association, who was to be a key figure in Nuffield physics, was a delegate at a conference on school science curricula held by UNESCO in Hamburg, Germany, and was encouraged by the ideas raised at this conference. John Lewis, a physics teacher at Malvern College, who became associate organiser of Nuffield physics when Rogers was appointed, had visited PSSC and also West Germany and the Soviet Union to discuss the new developments.<sup>35</sup> Such contacts continued after the launch of the Nuffield project. Rogers himself for example took the opportunity to elaborate on his vision for school

physics at a Commonwealth education conference held at the University of Ceylon in 1963. The principal aim of science teaching, he reiterated, was to encourage understanding: 'Science should appear to pupils as a growing fabric of knowledge in which one piece that they learn reacts with other pieces to build fuller knowledge.'<sup>36</sup> For Rogers, therefore, the ultimate purpose of O-level physics was in order for pupils 'to understand physics as a well-woven fabric in which experiment and theory play complementary parts, and to think of scientists as intelligent, sensible, skilful and imaginative people'. Indeed, he declared, pupils performing experiments could be 'scientists for a day'.<sup>37</sup>

Rogers maintained his position at Princeton University after he became organiser of the Nuffield physics project, and this transatlantic link became a key feature in the development of the project. The American connection was at the heart of the project, although it did not lead necessarily to straightforward imitation but rather to creative engagement. One example of this was around the ticker tape experiment for demonstrating velocity, pioneered by PSSC. Rogers was in favour of including this in Nuffield physics, but aimed also to improve on this basic design. As he explained privately in August 1963, 'At the moment, we are planning to have trolleys and ticker-tape like PSSC. I myself would not mind keeping to them and not expanding into ones with speedometers, etc.' He anticipated that this decision would disappoint some of the regions, and, he suggested, 'There is also the point of pride that all the Nuffield investigations would have led us back to the one PSSC has formed.' So the issue was how to retain the trolleys and tickertape while developing a 'Nuffield way' of measuring velocity. Rather than using the PSSC-style ticker tape, which would mean 'having to expand again and again to beyond what the analysis means', he preferred using a scheme of using a Panax 1000 cycle pulser to count the pulses.

This led him to argue that a system of using multiple photographs would also be needed. In practice, however, this approach might be too expensive for most schools to adopt, especially if it might require purchasing a number of Polaroid cameras. He pointed out that 'when our Nuffield apparatus appears to be expensive, LEA controlling East Overshoe will stop the Polaroid camera first of all'. Thus, he concluded, 'we should recognise that, like having a second car in the family, to have a Polaroid is a piece of American richness that we should not impose'. This meant choosing between an ordinary cheap camera and a home made one, and he proposed a home made model that had again been designed in the US. This used paper rather than film and had been employed successfully with large classes. This again involved borrowing from the US but there was at least some mitigation for this in Rogers' mind: 'I am sorry to suggest contemplating another American design but at least this one was made by an English technician that they imported to America.' He had asked the Scottish team to try this equipment but they had found difficulties and, Rogers suggested, 'I have the feeling they did not give it a fair trial.'<sup>38</sup>

Rogers' approach to the trolleys and ticker tape highlighted a number of aspects of his leadership of the project. First, he retained a passion for his vision of theory and experiments, which he used to combine as far as possible the best of British and US designs. Second, he had an eye for detail with which he insisted on being closely involved. Third, he was aware of the likely practicalities of cost and difficulty that would arise once the equipment trials gave way to a full run of the programme. Finally, he was highly suspicious of inspectors and bureaucrats – the officials of 'East Overshoe' – and of different factions and interests that might undermine his vision of the programme.

These were key features of Rogers' interaction with Nuffield physics from his base at Princeton University. He made sure that he attended as many meetings as possible, which involved a large amount of travel across the Atlantic. At the same time, he kept up to date through airmail correspondence, telex messages and long distance phone calls. This kind of transatlantic contact was fundamentally different from his writings to Badley in the early 1930s. His earlier correspondence had been reflective in nature and took time to write and receive. They were meant to describe and discuss the situation as it existed, rather than to intervene and affect the situation on an ongoing basis. By contrast, his role as organiser of the project meant that he was continually sending messages, often on comparatively small points of detail, to other project leaders. This led in turn to personal frustrations and stress as the pressure of completing the trial stage of the project became increasingly fraught. Besides the mounting expenses of the travel and communications, there was some determination to keep the findings of the trial stage confidential and secret from the wider public until they were completed, while there were also growing time pressures to complete them within a few years.

This combination of factors led to the relationships between Rogers and his associate organisers, Ted Wenham and John Lewis, becoming increasingly difficult. Wenham, based at Worcester Training College, usually managed to keep the peace but Rogers and Lewis were often at odds. In a private note, Wenham pointed to the 'personality clashes' between Rogers and Lewis on the one hand, and also between Rogers and John Maddox, who was responsible for the project at the Nuffield Foundation. According to Wenham, Rogers was 'brilliant, sensitive, with an outstanding course', but was an 'absentee landlord'. Meanwhile, he noted, Lewis had made a 'great contribution' to English physics teaching but was 'not at his best

at this level', and 'has found it difficult to get Eric's [Rogers'] confidence and is depressed about it'. He saw Maddox as 'very able, somewhat insensitive and lacking tact, concerned to develop an administrative machine which creaks badly because it is not geared to needs of trials and schools' He concluded that the project was 'stuck with an absentee landlord for better or worse'.<sup>39</sup>

These tensions were reflected in Rogers' messages from the US. For example, he began one long note to Maddox, from Palmer Physical Laboratory at Princeton University, 'This follows my telegram to you today. Your notes for a paper on Board examinations has arrived and I am anxious to get a reply back to you in time. A telephone call would have cost me less than that long telegram, but I thought the telegram would put my comments more clearly.'<sup>40</sup> In March 1965, Rogers wrote to Wenham that he was 'gravely concerned' at the way in which decisions were being made at the Foundation: 'I get word with just time to reply, now often by cable (which is proving very expensive). I fear I must take strong measures and at the same time try to hold things in order in this respect.' He added that Wenham appeared to be missing some of the key meetings.<sup>41</sup> Wenham responded that he saw his own role in the project in part as 'an encourager of the flagging; the universal uncle upon whose shoulder all and sundry can weep salt tears', observing diplomatically that 'we all (on both sides of the Atlantic) are over-pressed'.<sup>42</sup>

Creating suitable new examinations for the new courses and gaining the cooperation of the examination boards was a further challenge. There was no textbook for pupils, with only a resource book designed for teachers. The examination, like the course itself, had to be designed to encourage an understanding of science. To this end, Rogers devised meetings held at the briefing conferences at Loughborough University in 1974, which were described as 'shredders'. The participants each



drafted a question which was circulated to the group and discussed intensively.

Extensive negotiations took place with the examination boards, and it was the Oxford and Cambridge board, already associated with the most elite or able pupils, that took responsibility for the Nuffield O-levels.

The trials were developed with the help of regional panels and practising physics teachers from schools around the country, mainly grammar and independent schools. A complete draft of the first four years of the pupils' course was trialled in 16 schools in 1963-64, then extended to about 50 schools the following year, with the aim of having a first version of the complete range of teaching materials prepared for large scale production by the start of the 1965-66 teaching year. The teachers' guide for Nuffield physics pointed out that it was intended for the most academically able pupils, with 'the standard of the "B" stream of a three-stream grammar school at the centre of our target'. Nevertheless, it was designed as a programme of 'physics for all' suitable for the general educated man or woman. The emphasis, as it reiterated, was on teaching for understanding rather than on collecting information or memorising formal statements by rote, or solving mechanical problems by formulae, or carrying out routine measurements by following detailed instructions. The vision for this Nuffield approach was of pupils 'not just when learning physics at school, but a dozen years later when they are in the world: a young man working in a bank, presently to be a manager; a lawyer, who must deal with scientists and even with science; a nurse; the manager of a shop; a history teacher in school or university; and the mother or father of young children who in turn will approach children with an attitude – of delight or boredom – that starts at home'. Physics itself was conceived as 'a connected fabric of knowledge, in which something learnt in one place proves useful somewhere else, and something discovered later throws light on something

worked out earlier', as pupils thought things out for themselves, learning physics as they did so.<sup>43</sup> These prescriptions echoed Eric Rogers' philosophy when in the United States, before the start of the Nuffield project; and to the extent that this was true, it was largely the achievement of Rogers himself.

#### **4. Conclusions**

The progressive enthusiasm and idealism of the youthful Rogers in the 1930s were still recognisably present in the Nuffield physics organiser of the early 1960s, while both the form and the content of the transatlantic communications helped to shape the character of Nuffield physics as a transnational project.

This transnational dimension also helps to explain the difficulties and limitations of Nuffield physics. Rogers found himself traversing the Atlantic Ocean both in bodily form and in his exasperated phone calls and messages. Nor did ideas that originated in one place always sit well in a different time and place. There was some resistance to the notion of imitating the educational practices of the United States. The translation and interpretation of the project in the English context may have found some advantages in the established academic tradition of the English grammar school, and it was able to enter into fruitful partnerships with the Ministry of Education, the Nuffield Foundations, and teaching associations. On the other hand, its finer ideals were less well suited to the rigid and established demands of examination boards. Moreover, the trend towards reorganisation of secondary education into comprehensive schools in the 1960s was not altogether helpful to its position, as it was not clear how well it could be adapted to the needs and interests of a wider range of pupils.

At the same time, this transnationality lay at the heart of the achievements of Nuffield physics and of its ultimate significance. First, it involved ideas and practices that crossed national borders, and indeed oceans and continents, over time and space. The progressive ideals of the 1920s and 1930s, developed over the previous generation at Bedales school, were translated into American designs and approaches in a later generation and crossed the Atlantic again to emerge in the Nuffield physics project. The concept of pupils as scientists was one that reverberates in different forms in and across a range of educational arenas. The tickertape experiment was one of many practices that were tried and tested in the United States and interpreted in Britain. Over a professional lifetime, the mobility of Eric Rogers in engaging with the educational problems of his youth and early adulthood in a different national context through his mature adulthood, and then investing this experience once again in his own homeland, again exemplifies this transnational set of aims and processes. In the end, too, this curriculum project can afford us some hope and optimism even in our most pessimistic times. It suggests that curriculum change takes place across time, often many years, and space, encompassing large distances. It proposes also that the legacy of the progressive schools is only 'lost' when considered in static terms, bounded by its own narrow and limited time and space. It need not be consigned to such a place, nor even to a single school, or city, or nation. This legacy can be reinvented, reconceived, in different circumstances with other players to work out its possibilities for new generations, in the 1960s, and perhaps still for generations yet to be born.

## REFERENCES

This chapter is a revised version of a professorial inaugural lecture, ‘Curriculum change across time and space: Eric Rogers, Nuffield Physics and Worcester Training College’, delivered as visiting professor at the University of Worcester, 12 June 2019.

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<sup>2</sup> See e.g. B. Simon, Education and the Social Order, 1940-1990, Lawrence and Wishart, London, 1990, esp. Part II.

<sup>3</sup> M. Waring, Social Pressures and Curriculum Innovation: A Study of the Nuffield Foundation Science Teaching Project, Methuen, London, 1979. On Nuffield Advanced level physics, see K. Fuller, D. Malvern, Challenge and Change: A History of the Nuffield A-Level Physics Project, 1993.

<sup>4</sup> W. Boyd, W. Rawson, The Story of the New Education, Heinemann, London, 1965, p. 187.

<sup>5</sup> Safari project, University of East Anglia, memorandum, ‘The Nuffield Approach’ [n.d.; c. 1974], p. 3.

<sup>6</sup> R. Lowe, The Death of Progressive Education: How Teachers Lost Control of the Classroom, Routledge, London, 2007.

<sup>7</sup> C. Rogers, ‘The lost legacy of progressive schools’, Times Educational Supplement, 24 May 2019, p. 18.

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