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The Nuffield Physics Ordinary-level Curriculum Project in the 1960s: a Transnational Project?

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Abstract: The Nuffield Physics curriculum project was the first national curriculum project held in the UK. The Ordinary-level Nuffield physics project, developed between 1962 and 1966 for academic pupils in grammar schools, was one of the most interesting and innovative projects of the 1960s. It had many transnational features, with influences of ideas and practices running across national borders, as well as national characteristics. It owed many of its distinctive ideas around physics for the inquiring mind to Eric Rogers, and ultimately to the progressive school Bedales in the 1920s and 1930s, as well as American reform under the banner of the Physical Science Study Committee. These were played out at a local level, for example in Worcester, led by Ted Wenham and John Lewis. During and after the project, although there was some resistance to sharing these ideas as they developed, key figures began to engage with other national systems and projects in spreading the word about Nuffield physics. Transnationalism was at the heart of the significance and achievements of Nuffield O-level physics, no less than of its problems and limitations.

Keywords: Physics; science; curriculum; transnational; inquiry; teachers.

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1. Introduction

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. The current paper explores 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, including its personal and ideological connections with the United States and also elsewhere. It might indeed be regarded as a transnational project in curriculum change (see also: McCulloch, 2020).

In a transnational perspective, educational processes and phenomena that run across national borders, often in both directions, are fundamental to an understanding of the social construction of the curriculum and of curriculum policies over time. Such processes and phenomena include for example ideas, practices, reforms, individuals and movements, and specific educational devices such as apparatus, textbooks, and syllabuses. Awareness of these features has underpinned recent research that goes beyond and effectively challenges the traditional historical narratives based on nation-states (McCulloch, Goodson and González-Delgado, 2020). National and local issues continue to be evident in such analyses. National traditions and the dynamics of political and social relationships within each nation are powerful factors in shaping and responding to transnational currents, and it is important to examine the ways in which they have done so in different cases. It is no less significant to determine the role of local sites in mediating and implementing both transnational and national processes in action. The Nuffield Physics O-level curriculum project of the 1960s provides an instructive example of all three aspects in relation to each other.

Josep Simon has found that the Physical Science Study Committee in the United States in the 1950s and 1960s was transnational in nature, with many leading PSSC staff travelling to different countries and being exposed to a range of national cultures (Simon, 2019). The project organiser of Nuffield O-level physics, Eric Rogers, also had a transnational role. His ideal of physics for the enquiring mind, developed in a widely influential text, was based on his transatlantic experiences. There is a significant place reserved also for the local connection of Worcester, which became a key centre for Nuffield physics, through the role played by Worcester Training College, later incorporated into Worcester University, and its local schools; and of E.J. «Ted» Wenham at Worcester Training College, and John Lewis at the nearby Malvern College. During and after the project, too, key figures also began to engage with other national systems and projects in spreading the word about Nuffield physics. The current paper engages with the personal archives of Eric Rogers and Ted Wenham, as well as the relevant institutional archives, to highlight these issues. Its broader significance is to demonstrate the dynamics of curriculum processes across time and space, and also the underlying theme of progressivism which has been neglected in previous work on Nuffield Science in the 1960s.

2. Nuffield O-level Physics

The Nuffield Foundation Science Teaching Project (NFSTP) marked the beginning of a concerted phase of curriculum reform in Britain in the 1960s. It reflected 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 (McCulloch, Jenkins and Layton, 1985). As such, it was perhaps overshadowed by the egalitarian reforms of the 1960s such as progressive education

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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 (Simon, 1991).

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 [Waring (1979); on Nuffield A-level physics see Fuller and Malvern (2010)].

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» (Boyd and Rawson, 1965, p. 187). 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» (Safari project, n.d.; c. 1974, p. 3). 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 quite capture this heritage (Lowe, 2007). Thus, it has been asserted that progressivism in English schools is a «lost legacy» (Richards, 2019). 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 on the history of school science by Michael Argles in the 1960s (Argles, 1964), followed in later decades by writers such as David Layton, Ingle and Jennings, and Edgar Jenkins (Ingle and Jennings, 1981; Jenkins, 2019; Layton, 1973) and by Brian Woolnough on school physics (Woolnough, 1998, 1990), 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.

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.

The transnational dimension can be closely linked to the biographical aspect. Recent research has focussed on the marketing of the Dalton Plan in Great Britain in the 1920s, correspondence between London and New Zealand for the New Education Fellowship in the 1930s and 1940s, and European networks linked to curriculum policies in Portugal in the 1960s (Del Pozo Andrés and Brasker, 2018; Estrela, 2019; Middleton, 2013). 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 remined unknown for another generation, but the changes by the mid to late 20th century were already immense, and helped to reshape the nature of transnational connections within the span of a professional lifetime.

3. Eric Rogers and Nuffield Physics

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 [see Fuller (1994) for further biographical details].

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.

During his initial sojourn in the US while at Harvard in 1930-32, Rogers conducted a correspondence with J.H. Badley, the head of his old school, Bedales, keeping him up to date with his plans and reflecting on his experiences. 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 US, and clearly weighing up the problems and advantages of each and assessing potential ways forward. 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

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the crucible for an educational career in which his reforming instincts came to the fore in his chosen subject, physics.

Rogers 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) (Rogers, 1931a). 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 (Rogers, 1931b). 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. 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» (Rogers, 1932). 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» (Rogers, 1931c).

These ideas also influenced his approach to teaching physics. 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» (Rogers, 1931a). 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.

Rogers 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. He preferred 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. 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 (Fuller, 1994).

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. The PSSC was 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 [see Rudolph (2002, esp. Ch. 5)].

At this time also, Rogers prepared what became his best known work, *Physics for the Inquiring Mind* (Rogers, 1960), followed in 1962 by *Teaching Physics for the Inquiring Mind* (Rogers, 1962). 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 (Rogers, 1962, p. 2).

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 (Rogers, 1962, p. 2).

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. His ideals, forcefully expressed, provided the central basis for the transnational connections underlying Nuffield O-level physics in its formative years.

4. The origins of Nuffield Physics

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.

As early as 1956, Henry Boulind of the Science Masters' Association (SMA), 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. However, he suggested that there was a national rather than an international basis for further action, stemming from what he called «the present climate of opinion in schools and universities, and in technology and industrial administration». He pointed out moreover that «Adequate scientific education is essential for the whole population, and certainly for the 20% of pupils of

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"grammar-school type" who will become "men of affairs" in administration, industry, business, teaching or other professions». (Boulind, 1956). This view implied that priority should be given to the twenty percent of pupils who were educated in grammar schools, and to the Ordinary level courses designed for such pupils as well as the specialised Advanced level courses in sixth forms for fifteen to eighteen years old. The SMA, the Ministry of Education and the charitable Nuffield Foundation worked together informally at a national level to achieve these ends, as has been well recognised in earlier research [see Layton (1984, esp. Ch. 10); and McCulloch *et al*. (1985, esp. Chs. 5, 7)].

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». 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 (Tricker, 1961).

There were many international events and visits that helped shape the ideas underlying the Nuffield O-level project, besides Tricker's visit to the US. John Lewis, a physics teacher at Malvern College, visited the US in July to August 1960, attending a PSSC Summer Institute in Boulder, Colorado. He was then awarded a travelling scholarship by the Goldsmith's Company to visit first West Germany and then the Soviet Union in the Easter term of 1961. In West Germany, travelling to Cologne, Heidelburg, Gottingen and West Berlin, Lewis was impressed by the high quality of physics equipment but found little experimental work done by pupils in the schools. In the Soviet Union, it was the detailed guidance provided for teachers that made the strongest impression (Lewis, n.d.).

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 (McCulloch *et al*., 1985, Chapter 7).

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 (Rogers, 1963a).

This led Rogers 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» (Rogers, 1963a).

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.

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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 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.

5. The Worcester connection

This combination of factors led to the relationships between Rogers and his associate organisers, Ted Wenham and John Lewis, becoming increasingly difficult. Wenham, a graduate from Kings College London, and previously senior physics master at Sevenoaks School, was based at Worcester Training College. He usually managed to keep the peace, assuming a key role as the diplomat among the organisers, 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. Thus in practice the transatlantic and transnational features of the Nuffield physics were mediated and translated at the local level. 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 concluded that the project was «stuck with an absentee landlord for better or worse» (Wenham, n.d.).

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 1964, 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.

Wenham's influence led to Worcester becoming increasingly prominent in the project, and this was soon noticed by Rogers himself. A Ministry of Education official writing to Wenham that in Rogers' view «there is some interesting work in Worcester» (Williams, 1964). In the late 1950s, the training college had established a third year course in science which soon became obligatory for students who wished to follow a career as specialist science teachers, in effect beginning a three-year course of teacher training in science. It was still a constituent college of the Institute of Education at the University of Birmingham, but with its specialist course established it was able to furnish a new building with four specialist staff and several specialist laboratories (Wenham, 1961).

Wenham had a key role in these developments as senior lecturer in physics at the college. His links with local schools helped them to become actively involved in the physics trials – in particular Worcester City Grammar School, the Girls' Grammar School, and Bromsgrove County High School. Wenham was also directly responsible for the invention of what became known as the «Worcester circuit board», which was very much in the spirit of the general approach of Nuffield physics, as it helped to explain and understand the nature of electric circuits (Collins, 2011).

6. Planting seeds?

During and after the establishment of Nuffield O-level physics, its key figures were in increasing demand to advise other countries about lessons to be drawn from the experience of the project in England. At first, this was not always welcomed, as it was seen as a distraction, and also seemed to threaten the confidential nature of preparation work. However, overseas conferences and commissioning came to be a familiar part of the support provided by Nuffield physics, providing an additional feature to the transnational character of the project itself.

As the Nuffield science projects began to make progress, it was noted that there were a number of agencies outside Britain that were also interested in science curriculum reform. Of these, the most relevant appeared to be those in the US, which were now being actively propagated in other countries, including many that were in the view of Nuffield officials «basically unsuitable for the purpose». This lack of suitability was because

> in former British Africa and many parts of the Far East, Australia and New Zealand, the school pattern is modelled on the British rather than the American system; yet many of these countries , in the absence of a comparable lead from Britain, are beginning to get committed to American curriculum schemes (Nuffield Foundation, n.d.; 1963?).

It was also observed that new work was in progress on school science teaching in the Soviet Union, Germany, Italy and Sweden, although this was seen, «for understandable reasons», as having «a less obvious relevance to our own problems». The main international agencies in this area of work were recognised

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as being Unesco and the OECD, while these appeared to lack funds which confined them to conducting international surveys, holding conferences, and publishing general recommendations (Nuffield Foundation, n.d.; 1963?).

One example of an approach from overseas that met with a reluctant response at this time came from Unesco, whose representative wrote in August 1963 to request detailed information about all of the Nuffield science projects, and to ask to meet their organisers (Bandyopadhyay, 1963). Tony Becher at the Nuffield Foundation referred this approach to the Curriculum Study Group at the Ministry of Education, explaining that his inclination was «very much against our getting directly involved with Unesco at this stage», and hoping that the Ministry might «be prepared to act as a buffer for us» and to divert this «enthusiasm» in other directions. Indeed, he added, «We certainly do not want to give them any very detailed account of the scheme, nor do I think it reasonable to ask our organisers to take up too much of their time in discussing it with them». He conceded that it would be proper «out of politeness if nothing else, to show the flag briefly» for any visitors, but hoped that this could be delayed to a later date (Becher, 1963a). For his project organisers, Becher's response was even franker:

> I am inclined to interpret Mr Bandyopadhyay's rather peremptory manner charitably and to ascribe it to his inadequate command of English. This approach from Unesco is clearly rather a nuisance at the moment, but I suppose that we shall have to go through some polite and general motions with him (Becher, 1963b).

When Unesco's representative did indeed defer his visit, Becher wrote a private note on a copy of his formal reply to signal his relief: «Whew! A momentary reprieve, at any rate. I suppose we should be thankful for small mercies» (Becher, 1963c). However, Rogers did take part in a Commonwealth conference on the teaching of science in schools, held in Ceylon in December 1963, contributing a keynote paper on the aims of science teaching in schools (Rogers, 1963b).

As we have seen, Rogers was no stranger to transnationalism, and he continued to pass on the lessons of his own international experience through further travels and discussions in different countries. In early 1967, for example, he embarked on a lengthy visit to Latin America, «partly to fulfil some old promises dating back to some keen visitors here». He took with him nearly all Nuffield materials, mainly books, and was ready to engage with queries about how to engage with examining bodies in the process of revising the syllabus (Rogers, 1967a). By the end of his visit, he reflected on the importance of actively promoting a project such as Nuffield physics which had already been brought in from elsewhere: «Otherwise I fear projects will continue to be received with joy and shelved with neglect». In Peru, which he found especially independent and self-sufficient, he found both a «pleading for support» but also, «the pride rides higher still». At the same time, he added, «Of course it is very difficult to tell if one has had any success because this is a matter of planting seeds and then waiting a long time before one knows if they will grow at all» (Rogers, 1967b).

In the case of John Lewis, these transnational activities continued both at a personal and at an institutional level. He was invited to present conference papers and reports in many countries including Brazil, Turkey, the United States and Israel, and lectured for the British Council and Unesco in Venezuela, Jamaica, Tanzania, Zimbabwe (then Rhodesia), Japan and the Philippines. He became vice-president of a new association entitled Groupe International de recherche sur l'enseignement de la physique (GIREP) which held meetings in Malvern, Venice, Montpelier Oxford and Rehovet. He became a member and then secretary of the International Commission on Physics Education, and later helped to organise major international conferences held in Edinburgh and Oxford (Lewis, n.d.).

7. Conclusions

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 (Nuffield Foundation, 1966, p. 1).

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 (Nuffield Foundation, 1966, pp. 1-2).

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 (Nuffield Foundation, 1966, pp. 1-2).

These prescriptions echoed Eric Rogers' philosophy when in the US, before the start of the Nuffield project; and to the extent that this was true, it was largely the achievement of Rogers himself. 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

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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 Foundation, 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 reverberated 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 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. Announcements of the death of progressive education may yet be premature. Its ultimate fate may yet depend on transnational projects such as the Nuffield O-level physics course of the 1960s.

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