

# **How Knowledge Moves**

*Writing the Transnational History of  
Science and Technology*

**EDITED BY JOHN KRIGE**

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## CHAPTER ELEVEN

## The Transnational Physical Science Study Committee

### *The Evolving Nation in the World of Science and Education (1945–1975)*

Josep Simon

In 1964 Robert I. Hulsizer became director of the Science Teaching Center of the Massachusetts Institute of Technology, after more than a decade at the University of Illinois and after playing a key role in the development of the Physical Science Study Committee (PSSC). He had graduated as a physicist during World War II, worked at the Radiation Laboratory, and received his doctorate at MIT. On coming back to MIT he advocated the preparation of a new freshman physics course, which he characterized as “like trying to describe an evolving nation. It exists and therefore can be characterized at its present state. Yet one’s view of the course is a mixture of past tradition, past and present hopes and partial realization of these hopes.”<sup>1</sup>

Another major actor in the making of that MIT course, Anthony P. French,<sup>2</sup> emphasized in his proposal MIT’s “well-developed tradition of strong and respected courses in introductory physics.” This tradition had started in the 1930s with Nathaniel Frank’s courses, followed by Francis Sears’s textbooks and Jerrold Zacharias and Francis Friedman’s PSSC. The new course would be another step in that tradition, for the service of MIT and the nation. French’s narrative was an essentially local and national one radiating out from MIT and the United States to the rest of the world.<sup>3</sup>

The PSSC, the major project to which Hulsizer’s and French’s experiences and imaginaries refer, developed a new physics course for American high schools between 1956 and 1960. The PSSC was supported by grants from the National Science Foundation (NSF), the Sloan Foundation, and the Ford Foundation, with headquarters at MIT and the University of Illinois. It was a large and complex project that used a military-industrial management model, a major novelty in the production of teaching materials. In 1960 the first edition of the PSSC’s *Physics* was published. A few years later, almost half of the nation’s schools were using PSSC materials, and its textbook had been translated into a dozen languages.<sup>4</sup>

French and Hulsizer’s testimonies mark the PSSC as a major and recent milestone in an “evolving nation,” which was further evolving through the production of new courses at MIT. In some of the pedagogical landmarks, mentioned by French, the goals and approaches localized in a particular institution (MIT) could be projected onto the whole nation. In other cases, such as the PSSC, there was a larger interaction and integration of aims and methods from different institutions and communities of practitioners in order to produce a pedagogical package able to build the nation and eventually to go beyond it. Indeed, this project, which sought to collapse US science education into one single national course able to boost the production of scientists, managed to spread its impulse of educational reform to Europe, Latin America, Asia, and Oceania. Today, the PSSC is seen by science educators as a common heritage of science education worldwide.<sup>5</sup>

The enthusiasm for physics teaching and for developing an exportable physics course that could spread throughout the world was in tune with the vision of MIT being advocated at the time by Gordon Brown, MIT’s dean of engineering. For Brown MIT was at the intersection between the past, present, and future. It had matured into a major center for engineering education, and its educational programs were ripe for exporting nationally and internationally. They were of a piece with the programs being advocated by MIT’s Ford Foundation-funded Center for International Studies directed by Max Millikan and Walt Rostow, who would promote modernization theory and nation building as tools of US foreign policy around the world.<sup>6</sup> Hulsizer and French were imbued with that same MIT “idea.” Their characterization of the MIT freshman physics course coupled the development of pedagogy and of the nation, and it located its force in both the continuation of tradition

and the imagination of new configurations. There is a powerful illustration of the strong connections between science education and the nation, and the national imaginaries of Cold War physicists, which fit perfectly with classic historical research on the nation and nationalism.<sup>7</sup>

Nationalism has not always characterized the writing of US national history. Historians of nineteenth-century American science studied the making of national institutions, but they also paid attention to the American observation and appropriation of the German, British, and French experiences.<sup>8</sup> In contrast, analogous work for the Cold War period favors the view that after World War II, US science and education had grown to become autonomous.<sup>9</sup> Despite the global importance of American science and science education in this period, it is worth asking if these facts constitute in themselves a *sine qua non* condition for the congruence of our historiographical perspectives with the national unit.<sup>10</sup> Undeniably, a nation exists with regard to other nations, and as a state, with regard to other states.<sup>11</sup> Educational reform is particularly illustrative of this, thanks to its cross-national tradition, since all types of nation-states (nonhegemonic and hegemonic) have commonly looked abroad for relevant experiences before undertaking substantial changes in education practices at home.<sup>12</sup> The PSSC illustrates well this dynamic in national and international affairs.

Decades ago, one of the prime movers in the development of transnational history was the urge to open American history to the world by overcoming its traditional exceptionalism.<sup>13</sup> Transnational perspectives could contribute to shaking the foundations of historical characterizations that were insufficient but had long held sway. This chapter takes the PSSC as an object allowing us to unravel the historical and historiographical elements that may justify narrating the history of US science and education from a local, national, international, or transnational perspective. Central to my approach is the discussion of the advantages and shortcomings of each of these perspectives.

Accordingly, I provide a big picture of the PSSC and its contemporary history in the United States and abroad. The first section of the chapter examines the making of the PSSC from a local and national perspective. The second section deals with the committee's internationalization. In the final section I discuss the findings presented in the previous two sections and the potential of applying a transnational approach to this case study.

## The American PSSC

The PSSC was born first as a local and personal initiative, but it rapidly expanded into a collective effort that assembled a large number of universities, colleges, and schools, physics professors and teachers, and educational researchers, technicians, managers, and consultants. It befitted the "signs of the times" and found major support in institutions such as the NSF, the American Institute of Physics (AIP), and the American Association of Physics Teachers (AAPT), which were developing programs to tackle the same problems. In this section I want to stress that although the PSSC was developed on US soil, its national (American) character was not a given natural quality but the result of a particular geopolitical infrastructure and the agency of certain project members.

Since the early decades of the twentieth century, some academic physicists in the United States had expressed dissatisfaction with the school curriculum, textbooks, and teacher training, emphasized the need to control and homogenize college requirements, and remarked on the tension between training physicists and training citizens and on the excessive reliance on European physics professors.<sup>14</sup> The decentralized nature of the American school system and the lack of interest among most university physicists had prevented any large-scale reform.<sup>15</sup>

By the mid-1950s, however, a series of events had merged to promote a widely generalized opinion in the US Congress that the country required a large investment in school science reform. The large number of specialized conferences held since the early 1950s and the National Defense Education Act of 1958 were key elements in this movement.<sup>16</sup> The newly created NSF (1950) managed to become the favored institution to tackle the problem of scientific manpower.<sup>17</sup>

Several initiatives were launched to improve physics teaching. In March 1956 Jerrold Zacharias, an MIT physicist, sent a memo titled "Movie Aids for Teaching Physics in High Schools" to the president of his institution. His project was couched in the language of atomic physics; it focused on experiment and film, and its pretension was mainly local and personal.<sup>18</sup> In parallel, and beginning in 1955, a series of conferences supported by the AAPT, the AIP, and other agencies had also begun to tackle the main problems of physics teaching.<sup>19</sup> A central actor in these conferences was Walter C. Michels of Bryn Mawr College,

AAPT's president-elect. He chaired a Joint Committee on Teaching Materials for High School Physics established by the AIP, the AAPT, and the National Science Teachers Association.<sup>20</sup> From 1960 Michels also chaired the AIP-AAPT Commission of College Physics, which developed a national survey of physics teaching programs with the aim of improving them. As national federations of physicists' societies and national organizations composed of regional sections in each US state, the AIP and AAPT had both the legitimacy and the capacity to conduct such an endeavor. MIT physicists were manifestly absent from these conferences,<sup>21</sup> a fact which limits the role that the historiography has traditionally given to MIT and its professors in the making of national science education and suggests instead the agency of other institutional and individual actors in this process.

A week after the 1956 AIP-AAPT Conference on Physics in Education, Zacharias sent a proposal to the NSF.<sup>22</sup> He was able to receive the support of MIT's president and chancellor and to use their connections and his war acquaintances to ensure the success of the application.<sup>23</sup> By September 1956 the project had taken its final name: Physical Science Study Committee. The Committee expressed interest in working with the Educational Testing Service (ETS)<sup>24</sup> in the development of its materials and the design of examination tools.<sup>25</sup>

The PSSC rapidly expanded through the incorporation of members from Cornell, Caltech, Illinois, and Bell Laboratories.<sup>26</sup> The team eventually included several hundred physicists, high school teachers, instrument makers, filmmakers, photographers, editors, typists, and educational test designers. To deal with the daily requirements of the project, Educational Services Incorporated (ESI), a nonprofit company, was created with its own staff.

By the late 1950s the PSSC preliminary materials had been tried in schools in Pennsylvania (three), Massachusetts (two), New Hampshire (one), New York (one), and Illinois (one).<sup>27</sup> Without undermining the importance of the official leaders of the project, Jerrold Zacharias and Francis Friedman at MIT, I should mention two other actors who, from a national perspective, had a major role in the making of the PSSC. Their relevance has often been downplayed in official accounts of the PSSC project, which has been characterized by a national pretension but a local (MIT) narrative.<sup>28</sup>

One of them was Walter Michels, whom we met a moment ago. Michels played a major role in the coordination and supervision of the pro-

duction of PSSC materials, especially with regard to their testing in pilot schools. Pennsylvania contributed three of the eight pilot schools and Michels's work was fundamental in this context. Furthermore, he had a knowledge of, and contact with, the nation's physics-teaching community, which other members of the PSSC did not possess. The physicists leading the project at MIT were not part of that community, nor did they demonstrate any particular interest in getting to know it.

The other major actor was the group at the University of Illinois, which led the production of the PSSC Teacher's Guide and the supervision of evaluation in the pilot schools. The University of Illinois had had a laboratory high school since the 1920s, developing close collaboration between teachers and university professors in science and education (which was atypical). It hosted the earliest project of science curriculum reform in the United States after World War II: the University of Illinois Committee on School Mathematics (1951-1961), funded by the US Office of Education, the NSF, and the Carnegie Corporation.<sup>29</sup> Some of its members subsequently joined the PSSC. As we saw at the outset of this chapter, before joining MIT, Hulsizer was a professor at the University of Illinois and a member of the PSSC group there. Not only his previous MIT training but especially his experience at Illinois with the day-to-day operations of the PSSC arguably played a major role in his subsequent hiring as director of MIT's Science Teaching Center.

Michels's and Hulsizer's actions at their institutions, working together and networking with schools, colleges, and teachers in Pennsylvania and Illinois, and extending beyond to a large number of institutions and practitioners in other US states (where Michels was very effective), really did contribute to shaping the nation through science education reform. If the PSSC became an "evolving nation" able to map a large amount of US political and educational territory, it was not exclusively because of the political power and scientific prestige of MIT physicists but especially because of the agency of other actors such as the aforementioned.

By 1958 eight teachers had been using preliminary versions of the PSSC course with around three hundred students. Summer training programs were offered by five universities for around three hundred teachers. By 1959 there were more than 10,000 students using the trial materials. The ESI bulletin that year included a US map displaying this expansive distribution.<sup>30</sup> In 1965 there were around 5,000 teachers and 200,000 students using the PSSC program of study, accounting for al-

most 50 percent of the secondary school students enrolled in high school physics courses in the United States.<sup>31</sup>

In parallel, regional groups met to study the PSSC materials. They emerged in all the states except Alabama, Arkansas, Hawaii, Kentucky, Mississippi, Montana, Nevada, New Mexico, North and South Dakota, Tennessee, Utah, Vermont, and Wyoming. Some of these meetings were organized around further state divisions or large metropolitan areas such as New York, San Francisco, Los Angeles, Chicago, San Diego, Philadelphia, and Boston.<sup>32</sup>

The largest increase in the number of schools using PSSC materials occurred along the East and West Coasts, in the Midwest (then called the North Central region), and especially around urban areas. The rest of the country—with the exception of Florida—did not use PSSC materials and accounted for roughly half of the nation's physics high school population. Some of these schools expressed their reluctance to adopt PSSC courses and their preference for other projects of curriculum development such as Harvard's Project Physics.<sup>33</sup>

During the early implementation of the PSSC course in American schools, the Committee had to negotiate with the College Entrance Examination Board (CEEB) to create a special achievement test for those who had followed the course. The CEEB was founded in 1899 by twelve eastern colleges as a way to regulate and rationalize the variety of examinations applied by colleges to select their students.<sup>34</sup> During the first half of the twentieth century, the CEEB expanded to win a national coverage.<sup>35</sup> In 1926 it began administering the Scholastic Aptitude Test (SAT). After World War II, the CEEB tests were published by ETS. The development of tests with regional or national aspirations in the United States had been especially boosted by the two world wars, to ensure that army recruits met a minimum educational standard. The tests were soon adapted to school and college management. The implementation of these test programs generated heated debates because they could lead to standardization of curricula and interference with the states' administration, and there was no consensus as to their purpose and value.<sup>36</sup> All the same, by 1966 around 800 colleges and 250 scholarship programs used CEEB tests in their admissions processes. This did not deter the PSSC team, who argued that the standard CEEB tests were designed to assess a traditional physics course and so were inappropriate for their students. To solve the problem for future school years, they worked with the CEEB and ETS to produce a unified physics test suitable for all students.<sup>37</sup>

We see then that to produce an American physics course, the PSSC had to rely on infrastructure and collaboration provided by other initiatives which were also aiming at building the US nation by standardizing evaluation in its schools and universities. ETS had been involved in the PSSC since its inception.<sup>38</sup> ETS tests were not only an end product but also a fundamental technique to shape the PSSC course, since the tests were seen as an objective technology to measure the course's excellence. The tests were also an advertising tool to promote the idea of the pedagogical superiority of the PSSC option, favoring its adoption over other courses in the nation's schools.<sup>39</sup>

The leaders of the PSSC did not all agree on what its national role should be. Although it aimed at targeting the largest number of American schools, some of the PSSC founding members had more restrictive and elitist views: "The course should be directed to the top 25 per cent of high school students with the aims of inducing more of them to move into advanced work and of creating in the others a cultural climate favorable to scientific activity."<sup>40</sup> Its pursuit of national supremacy was also challenged by other scientists and educators, who had different views on what physics teaching and American education should be. Many suggested the worth of more humility or denounced the presumptuousness of the PSSC endeavor and its leaders.<sup>41</sup> Moreover, there were other competing projects in physics teaching, and they all wanted to be adopted nationally.

The quotation from Hulsizer at the beginning of this chapter was from a special issue of *Physics Today* dealing with "introductory physics education." Among the wide range of perspectives presented,<sup>42</sup> a revolt against the PSSC national discourse was clear in some of the contributions. Some authors considered that what society required from American schools was "educating philosopher-scientists" instead of an army of professional scientists and engineers.<sup>43</sup> Others were against the PSSC pretensions of national sovereignty, calling for course diversity as a desired reflection of the pedagogical and national virtues of American culture.<sup>44</sup> Among these, Harvard's Project Physics would become one of the PSSC's main competitors at both a national and an international level. In the early 1960s, while the PSSC was implementing its strategy of national expansion, Jerrold Zacharias chaired a panel on education, as part of the President's Science Advisory Committee. In addition to eulogizing the PSSC program, he revealed some of his views on national schooling: "The school 'system' is a natural unit for reform. The system is an

organic, semi-autonomous unit of education, with pension plans and supervisors, principals, promotion and hiring procedures, specification of jobs, adoption committees. It has electoral responsibilities, public relations problems, budgetary experience. World War II measured armies by divisions because the division was the smallest military unit that included all services—infantry, artillery, tanks, and air. The school system is the 'division' of education.<sup>45</sup> These analogies were not rare in the 1960s.<sup>46</sup> They were grounded in a cultural context shaped by wartime experiences, which had brought the nation together as an integrated system to fight foreign enemies. After World War II these alignments survived in the minds of many people who had played a major role in the war effort, such as some of the PSSC leaders.

Victory in World War II and the start of a space race reinforced a nationalistic perspective in the United States that enhanced political, economic, and institutional support for endeavors such as the PSSC and contributed to shape the ethos of many of the PSSC team members.<sup>47</sup> Thus, in his President's Science Advisory Committee report, Zacharias felt entitled to omit two major aspects. First, he ignored any educational research produced before the 1960s. Second, he dismissed any contemporary study produced in Europe, arguing that they would be useful only if they could demonstrate their relevance to the American context, thus stressing US autonomy.<sup>48</sup> The declining influence of Europe was being replaced by the emerging rivalry with the Soviet Union that configured the Cold War and its historical narratives. The launch of *Sputnik* by the Soviet Union did not start projects such as the PSSC, but it did benefit them, at least in providing further impulse and support to the resolution of accumulated concerns about science education.

CIA and NSF reports on the efficiency of the Soviet Union's centralized system of high school education and university training made the comparative assessment of the failures of American science education even more dramatic. According to these reports, unlike the Soviet Union, the United States, with the political autonomy of its state governments and the stratification of its school system, could hardly aspire to produce a significant number of scientists in a short period of time, as required by national interest. Zacharias would surely have agreed with that. Opposition between American democracy and Soviet totalitarianism was a frequent argument in NSF reports regretting sourly the US lag revealed by the *Sputnik* affair. However, other US experts considered that while Soviet education was shaped by ideological indoctrination, this

had little effect on the training of students in subjects such as mathematics, physics, and chemistry. Scientific laws and technological problems were in fact the same whether presented in a communist or in a capitalist guise.<sup>49</sup> These reports obviously simplified the key features of American versus Soviet (or Russian) science education by reducing them to democracy versus authoritarianism: both countries had national cultures of science, education, and politics that were more diverse and complex than captured by these two adjectives. What matters for our purposes here is that this line of reasoning represents another way of making the nation (by reference to an external enemy). In this framework (international) comparison was relevant but was instrumentalized to serve a predominantly ideological, rather than educational, agenda.

Cold War historiography has greatly emphasized US-Soviet confrontation, in a narrative loaded with exceptionalism and a basic bipolarity.<sup>50</sup> If we look beyond the timeline imposed by the post-1945 emergence of superpower rivalry, however, we encounter longer-term narratives that can give a richer account of the historical phenomena relevant to understanding science education during the Cold War.<sup>51</sup> Comparative studies made with a view to learning more, rather than to establish superiority, appear to be a fundamental tool in the development of all national networks of education since the nineteenth century. Observers circulated officially or secretly across nations to compare the unknown with the known and to draw conclusions able to improve teaching and research back home. The United States was no exception.<sup>52</sup> Comparison involves a type of observation that is never symmetric (an observer is always subjective and politically biased) but it can at least be productive of new insights rather than simply used to dismiss the other. In this context, there was an international context for science education that was rapidly expanding, in which the United States would come to play a major role, but nonetheless, in which there could be reciprocal learnings, as the imperfect geometry of the "international" suggests.

### The International PSSC

In 1959, alongside a map of the PSSC's distribution in America, ESI's report included a picture of Prime Minister Nehru examining PSSC materials accompanied by US officers at an exhibition organized in India.<sup>53</sup> Two years earlier a translation into Thai of the PSSC textbook's first vol-

ume had been made by a recent Harvard physics PhD who would subsequently occupy important government positions in Thailand.<sup>54</sup>

The goal of the PSSC had been to develop American curriculum reform. During the late 1950s, however, in the course of developing the PSSC materials, the project started to receive expressions of interest from foreign individuals and governments. ESI responded to these demands. As they grew in number the Committee was obliged to develop a plan for its international projection. It conceived of the international zone as divided into three types of countries: (1) "Advanced Nations—where there is something for both sides to learn": Sweden, Norway, Denmark, New Zealand, Yugoslavia, Spain, Israel; (2) "Intermediate Nations—The problem is primarily one of adapting the PSSC course": Japan, India, Latin America, or "Countries with relatively well established systems of education"; (3) "Emerging Nations—Where considerable aid work has to be done before PSSC can be of benefit: African Nations" or "Underdeveloped countries." Projects of the first type could be funded with the help of the NSF. Those of the second and third types would require funding from other agencies.

Just before the publication of the PSSC course materials, ESI reported having received requests for information from 350 individuals in foreign countries (plus 200 from Canada). That year, ten foreign visitors participated in PSSC summer institutes and publicized the project in Denmark, Germany, Finland, and England. In 1960 the number of visitors was expected to multiply by six. Three Spanish-speaking countries, Japan, and Sweden requested permission for the production of literal translations of the PSSC textbook into their national languages. Other countries, such as England, Canada, Germany, and Brazil, asked permission to adapt the course. The US Information Agency wanted to have PSSC materials (including films) for distribution in their network.<sup>55</sup>

By 1966 more than fifty foreign teachers had attended PSSC teacher-training programs in the United States.<sup>56</sup> This mode of operation produced results. Thus, for instance, a summer institute visit by a Swedish representative had a major role in the development of a trial program in Sweden aiming to adapt the PSSC materials. Moreover, Norwegian teachers joined the project to form a Scandinavian team cooperating to produce new teaching materials.<sup>57</sup> A similar experience occurred in New Zealand.

ESI contended that some of the pilot countries could adapt the materials to their educational needs by including additional topics,<sup>58</sup> and that

"direct translation . . . will rarely be the optimal solution."<sup>59</sup> Some of the foreign editions adopted this view: the Norwegian edition incorporated an additional chapter, extracted from the PSSC Advanced Topics program,<sup>60</sup> and the Spanish edition was published in two volumes in order to be used in a two-year course (instead of the original one-year PSSC course). By 1964, only the Italian translation included all the course materials.<sup>61</sup>

After 1960 the bulk of the PSSC internationalization program was devised through the development of courses abroad.<sup>62</sup> Between 1960 and 1964 there were summer institutes in Israel, England, New Zealand (three), Brazil (two), Sweden, Italy (three), Nigeria, Uruguay, Costa Rica, and Chile, and conferences on the PSSC (or partially dealing with it) in India, Austria, France, Israel, Italy, Japan, and Southern Rhodesia.<sup>63</sup>

Foreign editions of the PSSC text were published in Denmark, Italy, Israel, Japan, Brazil, India, Sweden, Colombia, Canada, Spain, Norway, Turkey, (French) Canada, and France. Some of the films were in the course of being translated into Italian, they were purchased in India, and one of the films was translated into Spanish and shown at the 1963 Inter-American Conference on Physics Education (Rio de Janeiro) and at major universities in Mexico, Uruguay, Costa Rica, and Puerto Rico.<sup>64</sup>

In 1960 the PSSC began to develop a relevant on-site involvement in Europe at the request of the Organization for European Economic Cooperation (OEEC) and the NSF.<sup>65</sup> That year, the OEEC had organized at its headquarters in Paris a conference on physics education with the support of the International Union of Pure and Applied Physics. A report and a plan to develop pilot projects on science education in Europe were produced. Established in 1948 as a permanent institution to manage the Marshall Plan aid, the OEEC was now convinced that an economic recovery plan should involve the reform of school science education in its European member states.<sup>66</sup>

The PSSC team was approached by OEEC officials, and after a visit to England by Friedman, plans started to take shape for the organization of a PSSC summer institute in Cambridge (United Kingdom). It was held in August 1961 with the participation of teachers from France, Spain, Portugal, Ireland, Italy, Austria, Germany, Turkey, Greece, Iceland, the Netherlands, Switzerland, Norway, Denmark, the United Kingdom, Yugoslavia, Belgium, and Sweden.

The aim of the PSSC delegation, led by Uri Haber-Schaim, was to



have truly intensive sessions, allowing participants to leave the institute with a range of written documents leading to the development of pilot projects in the different countries. These meetings were also conceived as places where the rights for translation of the PSSC materials would be negotiated. The Cambridge meeting indeed produced some of these drafts, developed not from a national perspective but through multinational teacher teams (except for a report on Yugoslavia).<sup>67</sup> Subsequently, Haber-Schaim considered that an international organization like OEEC would not have the capacity to develop such a project. It was preferable to leave the initiative to national groups as exemplified by the model experience of the (American) PSSC.<sup>68</sup>

The circulation of PSSC staff members across the world also played a major role in the internationalization of its products. Friedman and Haber-Schaim were arguably the members of the project who had a greater input in the development of the project abroad. Haber-Schaim led summer institutes in Europe, Latin America, Africa, and Japan. He would subsequently lead the preparation of the second and third editions of the PSSC course in the United States. Friedman traveled to the United Kingdom, India, and Pakistan and prepared the implementation of the PSSC there:

In addition, the project benefited from the international impact of US physics research and the worldwide circulation of the physicists connected to it. Thus, Philip Morrison, a member of the PSSC since its inception and a physics professor at Cornell, was in Europe, Israel, India, and Japan in 1960 for research purposes. During his trip he distributed PSSC materials and publicized the project.<sup>69</sup> MIT physicists not directly connected to the PSSC program did the same.<sup>70</sup> During his trip to India, Morrison expressed his surprise about Friedman having arrived in that country earlier than him and thus overtaking him in introducing the PSSC there—he used a metaphor which illustrated precisely the political and commercial substance of the PSSC international mission: “Had Columbus met the Admiral of Cadiz in Havana harbor he would have a little greater surprise.”<sup>71</sup>

The earliest foreign editions of the PSSC course were translations into Spanish and Portuguese. In Latin America, there were three PSSC translations used in physics teaching a few years after the release of the PSSC materials in the United States. The first translation of the PSSC textbook was produced in 1962 in Spain and marketed in Spain and Latin America by the publisher Reverté.<sup>72</sup> It was used, for instance, in

Mexico, where knowledge of the PSSC was surely introduced early on by Luis Estrada, a Mexican PhD student who was a visiting student at MIT between 1958 and 1960.<sup>73</sup> During the 1960s Mexican physicists such as Estrada and Francisco Medina Nicolau conducted workshops on the PSSC at the Universidad Nacional Autónoma de México, and after the reform of its physics degree in 1966, a new general physics course was introduced which included PSSC course experiments and the replication of some of its instrument kits.<sup>74</sup>

The second translation of the PSSC course into Spanish was published in 1964 in Colombia by a team of ten Colombian MIT alumni and a group of physics and engineering professors from the major universities in Bogotá, with the support of the Organization of American States (OAS), MIT-Club Colombia, and the Colombian Association of Universities.<sup>75</sup> It was led by Alberto Ospina, a military naval engineer trained in electronics at MIT, who had witnessed the early development of the PSSC before returning home in 1958.

A few years earlier, the PSSC had been published (between 1962 and 1964) in Portuguese in Brazil. It was the result of a long-standing effort among Brazilian scientists and educators to improve science education, which was helped by the support of UNESCO in the creation of the Instituto Brasileiro de Educação, Ciência e Cultura (IBECC),<sup>76</sup> the development of ambitious plans to produce and distribute science kits in schools, and the support of US funding (Rockefeller Foundation, Ford Foundation) and inter-American organizations based in Washington, DC (OAS). The IBECC had a major role in the development of science education programs in Brazil and across Latin America during the 1960s and 1970s.

The IBECC was created in 1946 in Rio de Janeiro to administer UNESCO's projects in Brazil. Its involvement in science education came through the subsequent establishment of a São Paulo branch and the initiatives, from the early 1950s, of Isaias Raw, a young medical researcher based at the Universidade de São Paulo. Raw's interest in science teaching had taken shape since the late 1940s through his work as a science teacher in a São Paulo private school (conducted simultaneously with his university medical studies), where he edited a journal devoted to the teaching of science.

After getting his medical degree and a research stay in Severo Ochoa's biochemistry laboratory in New York, Raw returned to São Paulo with the idea of starting a project to change the standard paradigm of the

teaching of science in Brazil. As the scientific director of IBECC's São Paulo branch, he conducted a large series of initiatives on science education and popularization, including exhibitions, clubs, fairs, talent competitions, and TV programs. Furthermore, he developed a major program for the design and production of school science equipment and experimental kits. Started as an in-house project, it soon received funding from the Conselho Nacional de Pesquisas and from several Brazilian state governments. As the project grew to industrial size, it was a major success for Raw to secure funding from the Rockefeller Foundation (1957), which already played a significant role in the funding of the new campus of the Universidade de São Paulo and especially its medical faculty.

In 1956 Raw visited the United States and became acquainted with incipient American educational projects such as the PSSC. Subsequently, Friedman was designated by the Ford Foundation to visit São Paulo, but he soon became ill and was unable to travel. However, through Raw's contacts at the Rockefeller Foundation and subsequent missions of US scientists to Brazil, it became clear that the country had an enormous potential for the development and marketing of science pedagogical packages. Thus, in 1961 a funding agreement was established with the Ford Foundation for the distribution of IBECC's experimental kits in Brazilian schools, the training of science teachers, and, last but not least, the distribution of US pedagogical materials in Brazil.<sup>77</sup>

The IBECC followed the progress of the PSSC project by using some of the preliminary copies of the course material and working on them between 1959 and 1960. In 1961 it published the translation of the laboratory guide and started to produce some of the PSSC equipment. A member of the IBECC attended the 1961 PSSC summer institute in Massachusetts.

A PSSC institute was held in São Paulo in January 1962, with funding from the OAS and the Ford Foundation and technical advice from the NSF. The institute staff was composed not only of Americans but also included lecturers from Chile (Darío Moreno), Costa Rica, and the IBECC (Rachel Gevertz). Participants were from Brazil (nineteen), Colombia (five), Chile (four), Paraguay (four), Argentina (three), Uruguay (three), Costa Rica (one), Nicaragua (one), Panama (one), and Peru (one). Later on that year, another PSSC summer institute was held in Brazil, this one fully developed by IBECC staff, and ran simultaneously in Costa Rica and Uruguay. By then almost all the PSSC equipment was available through local production.<sup>78</sup>

In this context the translation of the PSSC textbooks into Portuguese was carried forward by a team of science teachers and university physics professors at the Universidade de São Paulo, the Universidade de Minas Gerais, the Pontifícia Universidade Católica do Rio de Janeiro, and the Universidade de Brasília, where the books were published. Between 1964 and 1971 around four hundred thousand copies of the PSSC course (split into four volumes) were sold in Brazil.<sup>79</sup>

Moreover, as a follow-up to its 1960 Paris conference, in 1963 the International Union of Pure and Applied Physics organized a conference on physics in general education in Rio de Janeiro with the support of UNESCO, the OAS, the Brazilian Ministry of Education and Culture, the Conselho Nacional de Pesquisas, the Centro Latinoamericano de Física, and the Centro Brasileiro de Pesquisas Físicas. The meeting gathered around 150 participants from across Latin America, Europe, the United States, and some Asian countries.<sup>80</sup>

This movement of teachers and physicists across countries was promoted and supported by national and international institutions. The NSF stated that its priority in relation to the science curriculum was the "development of materials potentially useful to schools across the country." However, its mission was also to cooperate with other national and private agencies specializing in foreign affairs to help circulate pedagogical materials, scientists and science teachers, and educational information, in order to fulfill "United States foreign policy goals."<sup>81</sup>

NSF officials confessed to being proud of the interest shown by other countries for new US curriculum materials. They were conscious of the regional importance of Latin America for the international expansion of their national projects, seeing themselves as having "special responsibilities in working with Latin American countries and the state universities in Central America." Moreover, they suggested that with regard to the sending of publications and materials, "information should be given as freely to people in other countries as to people in the United States," but since foreign relations were a complex matter,<sup>82</sup> discretion and cautiousness should prevail in order not to give the impression of "pushing United States materials in other countries," while helping those making requests.<sup>83</sup> Notwithstanding their prudence, the international circulation of PSSC materials was massive. For instance, in 1961 a copy of the PSSC Science Study Series book *Crystals and Crystal Growing* (1960) was mailed to libraries in practically every country in the world (with several copies sent to most Latin American countries).<sup>84</sup>