VOLUME THIRTY FOUR 2019

HISTORY OF TECHNOLOGY

The Institute of Historical Research,
University of London

BLOOMSBURY

HISTORY OF TECHNOLOGY

VOLUME 34, 2019

Edited by Ian Inkster

Special Issue:
History of Technology in Latin America

Edited by David Pretel, Ian Inkster and Helge Wendt

BLOOMSBURY ACADEMIC
LONDON • NEW YORK • OXFORD • NEW DELHI • SYDNEY

BLOOMSBURY ACADEMIC
Bloomsbury Publishing Plc
50 Bedford Square, London, WC1B 3DP, UK
1385 Broadway, New York, NY 10018, USA

BLOOMSBURY, BLOOMSBURY ACADEMIC and the Diana logo are trademarks of Bloomsbury Publishing Plc

First published 2019

Cover image: Boys climbing a bridge in Matanzas, Cuba.
© Kai Büttner/Alamy Stock Photo

A catalogue record for this book is available from the British Library.

A catalog record for this book is available from the Library of Congress.

ISBN:	HB:	978-1-3500-8559-6
	ePDF:	978-1-3500-8560-2
	eBook:	978-1-3500-8561-9
ISSN:	Print:	0307-5451
	Online:	2514-7838

Series: History of Technology, Volume 34

Typeset by RefineCatch Limited, Bungay, Suffolk
Printed and bound in Great Britain

To find out more about our authors and books visit www.bloomsbury.com. Here you will find extracts, author interviews, details of forthcoming events and the option to sign up for our newsletters.

CONTENTS

Machines and Texts: Writing the History of Educational Technology in Latin America

JOSEP SIMON

Today, Information and Communication Technologies (ICT) are portrayed as the solution to underdevelopment, for their capacity to improve education, business and good governance.[1] A significant amount of pioneering ICT initiatives for education designed in the US or Europe have used Latin America as a privileged ground to become global. A new literature that critically analyses projects such as One Laptop per Child or Computers for Schools in several Latin American countries is currently burgeoning in the field of Science and Technology Studies. Concomitantly, work produced within a range of disciplines interested in educational research is contributing to dismantle the restrictively presentist understanding of educational ICT as mere computing solutions, in favour of more comprehensive and nuanced definitions of educational technologies.

In this novel perspective, educational ICT would be a contemporary case study of a *longue durée* history of technologies in the classroom, including items such as blackboards, slide rules, textbooks, student and teacher notebooks, slide and film projectors, television and film, laboratory guides, examinations and tests, programmed instruction manuals, museum and laboratory collections, teaching machines and a number of utopian projects conceived to improve education. Research analysing these technologies and the practices associated with them is still scarce and scattered in several academic fields that do not often interact – among others, science and technology studies, history of education, history of science, history of technology, media studies, museum studies and contemporary science education. While the literature is large, its analytical quality is unequal, and a focus from the history of technology perspective is rare.

In this paper, I will provide an exploratory analytical review of this literature and my own research experience. I will start by providing a historically-contextualized

characterization of educational technology. Subsequently, through case studies on different Latin American national contexts, I will discuss the potential of investigating nineteenth-century patents of invention of pedagogical tools and teaching machines for primary education. Finally I will analyse the rise of audio-visual and mass communication in the context of US-Latin American cultural diplomacy during the Cold War. By necessity, the approach in this paper is more empirical than theoretical, and it presents a series of sketches that offer a partial coverage of a comprehensive view of this history in the Latin American region. Nonetheless, by adopting a broad perspective, combined with exemplary case studies and an interdisciplinary literature review, the main aim of this paper is to suggest a new historiographical and methodological agenda for research on education in Latin America within the history of technology.

TECHNOLOGIES OF EDUCATION

In 1970, the first Brazilian symposium on the teaching of physics was held in São Paulo under the auspices of the Sociedade Brasileira de Física (Brazilian Physics Society). A major panel was devoted to the teaching of physics in secondary education with the participation of university physicists, school teachers and science education researchers across the country. Presentations dealt with multiple aspects ranging from pedagogical philosophy to syllabi, examinations, teacher training, careers and salaries. A critical point was the discussion of the role of pedagogical packages imported from the United States – such as those of the Physical Science Study Committee (PSSC) and Harvard Project Physics – in changing how physics was taught in Brazil. Participants considered that these foreign initiatives had had great impact, especially through their textbooks. However, Brazilian schools required not just mere translations of foreign textbooks, but the national production of pedagogical packages adapted to the specific needs of national schools, teachers and students.[2]

Textbooks had been a traditional way of teaching physics in Brazil since at least the nineteenth century, and the problems of contemporary science teaching were often attributed to its bookish nature.[3] However, in this context, a novel and broader definition of these traditional teaching tools emerged. In discussion with his colleagues, Antônio S. Teixeira Jr., professor of physics at the Universidade de São Paulo and the author of a standard secondary school physics textbook, contended that it was not just a question of *texts* but of *technologies*:

> I consider this as technology too. Texts come together with a teaching material, an orientation, a work; it is an importation of a whole educational technology, linked to the text. The PSSC is not only a text but a set of materials.[4]

In fact, the PSSC pedagogical package, released in 1960 in the US and translated in Brazil a few years later, comprised not only a main textbook, but also other teaching materials.[5] However, Teixeira referred not only to these elements, but to the design features of a textbook, as a technology with an in-built pedagogical philosophy, technique and knowledge structure. Thus, the appropriation of a textbook into teaching practice commonly required specific training for teachers on how to use it, and its particular design could contribute to drive particular actions

involving teacher and students in the classroom. Technology and technique went hand in hand with the production and use of an object (a textbook) that many science and technology researchers oblivious to the epistemological relevance of education would qualify as 'the last existential act' in the making of knowledge.[6]

The PSSC project had originated in a proposal for the production of 'Movie Aids for Teaching Physics in High Schools' presented at the Massachusetts Institute of Technology (MIT) in 1956. Between 1956 and 1960, through a military-industrial inspired organization and grants from the National Science Foundation, the Sloan Foundation and Ford Foundation, the PSSC, constituted by a team of several hundred physicists, high school teachers, instrument makers, filmmakers, photographers, editors, typists and educational test designers, developed a new physics course which comprised a main textbook, teacher's guides, laboratory handbooks, scientific instrument kits, films and a series of popular science books. Its development included experimental trials at pilot schools prior to the commercialization of the packages, and training workshops for acculturating teachers in the use of PSSC materials. A non-profit corporation was established to administer the PSSC products.[7]

The project aimed at breaking with the ways in which physics had previously been taught – including the inadequacy of available textbooks and the excessive textbook-dependence of teaching – and to align the new applications of cinema and television with education. It grew from a proposal for the production of educational films into a more complex pedagogical package which also included scientific instruments, a textbook and several other printed materials. In line with contemporary educational psychology, these pedagogical materials emphasized depth over breadth by focusing contents and pedagogical rationale on the conceptual *structure* of subjects and on teaching through *inquiry*.[8]

The PSSC project was a success in the US and internationally. The earliest foreign editions of its main course were translations into Spanish and Portuguese produced and used in Latin America during the early 1960s.[9] Latin America was a privileged region for the production and trial of science teaching materials originally designed in the US or on site by local educationists and international agencies such as UNESCO. In the US, the PSSC project opened the way to subsequent projects of pedagogical innovation in physics (such as the Harvard Project Physics), other sciences (biology, chemistry, geology) and the social sciences. It contributed to establish a permanent base at MIT for innovative educational projects with international projection which – although not a cumulative history – has built a tradition running until our days. The type of projects launched by the PSSC at MIT would move during the 1960s and 1970s to educational projects on other subjects (e.g. technological and environmental studies, community education and medicine), the design of programmed instruction texts inspired in B. F. Skinner's teaching machines and Fred S. Keller's Personalized System of Instruction, and the production of computer generated films, and computer educational programmes and tutorials (e.g. ELIZA and PLATO).[10] It was this context that shaped the views of MIT entrepreneurs such as Seymour Papert and Nicholas Negroponte on the potential of computers for education, through concepts such as the 'Knowledge Machine' and 'constructionism' that contributed decades later to the establishment of MIT Media Lab and the development of projects such as One Laptop per Child (OLPC).[11]

Antônio Teixeira's definition of textbooks as technologies was received at first with some puzzlement at the 1970 Brazilian physics teaching symposium. But in the 1970s, in practice this conception became standard in the development of Brazilian projects for the teaching of physics such as the PEF (Projeto de Ensino de Física), the PBEF (Projeto Brasileiro para o Ensino de Física), and the FAI (Física Auto-Instrutivo).[12] Brazilian educational researchers were perfectly familiar since at least the early 1960s, with the new overarching concept of educational tools, teaching methods and pedagogical innovation projects as technologies. Moreover, they were part of the international development of systems of programmed instruction that blurred the boundaries between texts and machines. In this period, Brazil was also the centre of operations for UNESCO's pilot project of experimental science teaching which developed a programmed instruction course in physics combining texts, instrument kits and films.[13] Analogously, the Keller Plan developed by American behavioural psychologist Fred S. Keller (based on his Personalized System of Instruction), originated from conversations between Keller, a colleague at Arizona State University, and two psychology professors at the newly created Universidade de Brasília, where the method was first tried before being successfully implemented in the US.[14]

By the late 1960s Brazilian physicists were also experimenting with the implementation of computers in education. Sérgio Mascarenhas, director of the Institute of Physics at the Universidade Federal de São Paulo, considered that the great revolution of the twentieth century would not be satellites or nuclear physics, but the making of a whole new educational technology using computers, television, magnetic tapes and films, among others. According to him, in contrast to other type of industries limited by market saturation, this was a vast and ever-expanding market due to population growth and the increase of free time brought by machine civilization. In this context the rise of the electronic computer industry for education was an enormously lucrative business as developments in the US were demonstrating.[15] Efforts in this direction were also being developed in Brazilian universities. Mascarenhas argued against objections to the use of computers in teaching, that:

> It is not an inhuman technique for the fact that the student is learning with a machine. On the contrary: there are many teachers in Brazil that are machines much colder than computers.[16]

Mascarenhas' enthusiasm could not hide that the utopian forecast of the new machine-based pedagogy intended in some ways the substitution of teachers, and concealed that the design of each educational technology involves the implementation of a particular pedagogical philosophy.[17]

The close relationship between Latin America and the US in the making and definition of educational technology would not be accurately characterized by a history of continuities over half a century. Nonetheless, today, a number of projects originally designed in North America such as OLPC and Computers for Schools, exemplify again the intensity of these interactions. The impact of these type of projects in Latin America is currently receiving a great deal of attention within educational research, producing a large body of literature which however is often biased by a literal replication of the triumphalist statements of its developers.[18]

However, there is also a growing body of critical literature on this topic within the field of Science and Technology Studies which deserves mention.

Research on OLPC has shown the relevance of Latin America for contemporary computer in education projects. In 2012, more than 80 per cent of OLPC's international reach (affecting globally forty-six countries) was focused on ten Latin American countries. An ethnographic investigation of this programme in Peruvian rural primary schools revealed the sharp contrast between OLPC leaders' fundamental belief in educational transformation by expansion of technological access, and the serious failures of this programme. Designed at MIT as a global solution, the programme did not take into account the educational and cultural diversity of the numerous countries in which it was implemented. In contrast, engineers and social anthropologists working locally identified the need of developing collaboration with local teachers and students to produce a fruitful pedagogical appropriation of this technological package.[19] Thus, the traditional conception of centre and periphery mediated by diffusion – held by the project designers – was reconfigured as a productive process of negotiation in which a diversity of agents in rural areas located in so-called peripheral countries would be able to reshape the design of educational technologies in order to fulfil their intended mission.[20] An analogous study of the introduction of OLPC laptops in primary and secondary education institutions in Paraguay displayed the stark difference between OLPC designers' pedagogical ideals and the pedagogical philosophy required for these schools. Engaging with the culture of students, teachers and parents in Paraguayan schools was deemed a fundamental requirement to develop this educational programme, which paradoxically the MIT ideologues had not contemplated. In this perspective, OLPC leaders can be aligned with a view of educational technology shaped by a material and conceptual *fetishism* of machines. Moreover, this ethnographic investigation pinpointed the interest of applying the concept of *charisma* to research on the users and uses of educational technologies, as Paraguayan students, teachers and parents often thought that they were responsible of the programme's failure due to their inability to use its computers properly. This object charisma was ingrained in their more general expectation of joining the information society promoted by the Paraguayan government.[21] Similar conclusions and approaches have arisen in other Latin American countries for other computer in education programmes such as *Computadores para Educar* in Ecuador.[22]

The fact that understanding educational technologies requires dealing not only with technology but also with education, and that both involve particular social, political and economic rationalities which are contingent and changing in time and place, might seem a truism. However, as we have seen, it defies notions about new educational technologies commonly held by designers and the public.[23] In 1989, the second edition of a review volume on the computer revolution recalled that for more than two decades the claim that computers were about to revolutionize education had been periodically announced without actually happening.[24]

Although a particular definition of educational technology crystallized between the 1960s and 1970s in Latin America and beyond, it was far more diverse than what is usually meant today as ICT for education. Furthermore, a quick retrospective glimpse at our recent history is sufficient to evince the limitations of holding a single

definition of technologies of education. The presence of technology in classrooms and its use in teaching is much older and diverse. Accordingly, in the next sections I will go back in time and present briefly two case studies that exemplify an interdisciplinary but historically nuanced approach to educational technology.[25] The first section deals with patents for primary school teaching machines and techniques, the second with audio-visual and mass communication media for education.

PATENTS OF PEDAGOGICAL INNOVATION

The provision of teaching materials for schools was a high priority for the newly independent republics in Latin America since the early decades of the nineteenth century. This involved the supply of textbooks, which initially were often translations of European works or books especially produced for Latin America in cosmopolitan book trade capitals such as London and Paris.[26] Subsequently, this production was typically diversified and strengthened with the concurrence of national authors, and by the mid-twentieth century governments were making large investments in a national textbook production for primary and secondary education.[27] Textbooks as research objects for Latin American history have caught the interest of historians of education and educational researchers.[28] In contrast, research on other type of educational technologies is more limited. This is in fact an international problem for the history of education which is still finding its way towards the production of more analytical investigations on its material culture, through dialogue with other disciplines such as museum and media studies, science and technology studies and the history of science.[29]

Thus we know for instance that, in the first decades of the nineteenth century in Colombia, schools based on the Bell-Lancaster monitorial system of instruction were catered with writing samples, blackboards, carbon pencils, pens, inkwells, paper and charts dealing with topics such as spelling, morality, national constitution, grammar, arithmetic and geography. Although there was a plan to provide schools and universities with cabinets of physics, chemistry and natural history, it took several decades to introduce this type of educational technologies. Towards the end of the century, collections of machine models, scientific instruments and geological samples were purchased through agreements with European countries.[30] Similar characteristics are found in the supply of primary school materials in Mexico during the same period.[31] In the last decades of the nineteenth century, in Brazil, school materials imported for object-teaching included for instance: Parker letters, Prang models, Deyrolle and Saffray collection cabinets, lathes, anatomical models, physics and chemistry apparatus, and geographical, natural history and weights and measures system charts. In the first half of the twentieth century new items were added, for instance audio-visual means such as projectors and turntables.[32] In Argentina comparable collections were created and arranged in school museums through acquisition of pedagogical materials produced in France and Germany. Towards the end of the nineteenth century some local teachers and manufacturers were producing encyclopaedic boxes designed for object lessons in national perspective.[33] By the second half of the century the secondary schools in the major cities of Argentina, Brazil or Mexico had major collections for the teaching of physics, chemistry and

natural history.[34] The account provided here is eminently descriptive, as is the sample secondary literature in which it is based. In the following, I exemplify a more analytical approach that can show the potential to get deeper into our historical understanding of nineteenth-century educational technologies in Latin America. I have chosen a case study on patents for its ability to integrate several relevant lines of inquiry in this context. Dealing with patents, advertisements, or extant teaching collections is a mandatory prerequisite to document the Latin American contribution to the production and use of educational technologies. A selection of patents preserved in Mexico can serve as an illustrative example of this approach.

Extant patents or privileges for the exploitation of teaching inventions in nineteenth-century Mexico are in fact a very small part of all patents preserved in Mexican archives. They range from 1836 to 1890 (although primarily concentrated in the second half of the century) and represent less than one per cent of a corpus of documents privileging other fields of technological invention such as agriculture, transport, construction, mining or metallurgy. Pedagogical inventions were included in the class of 'stationery, teaching and popularization articles' subdivided in two further categories: 'office articles, letter press printing machines, bookbinding, teaching articles, and typewriters' and 'book jackets, publicity, mailing, communication by carrier pigeons and signals'. Documents on pedagogical invention preserved at the Mexico City and Mexican national archives are of two types: applications for permission to introduce or commercialize teaching inventions in the city's schools, evaluated by a municipal school commission (called *privileges*) and patents per se, which were subject to examination by a government commission. In practice, the process of patent evaluation rarely discussed the usefulness of inventions, but only their compliance with legislation and public safety. The loose practice of patent registration and control justifies a combined analysis of these two archival sets.[35]

Due to the marginal and fragmentary character of this documentation,[36] it would be difficult to produce a quantitative analysis able to explain the role of educational technology inventions in the transformation and improvement of educational practice, as it is often customary in economic history and the history of technology. In spite of the benefits of such an approach, it is well known that patents are not an exact measure of all technological inventions in a national context, that inventing is different from patenting, and it is still a matter of discussion whether patents have promoted or obstructed technological change.[37] The approach used here is qualitative, but it still serves the aim of suggesting ways in which the study of educational technology inventions could contribute to the study of educational practice and change.

If we discard the privileges awarded for the introduction of textbooks, primers, treatises or encyclopaedias in schools, there was a relevant number of privileges and patents that presented inventions of techniques and technologies aimed at improving teaching practice. These included reading, writing and counting techniques, and technologies integrating a number of different school subjects in the form of pedagogical systems, encyclopaedic boxes and teaching machines. Their authors are in general little known, they were Mexican,[38] and were teachers (in public or private schools), mechanics, traders or independent entrepreneurs. Among these inventions, writing techniques were in general implemented through the design of notebooks that included letter patterns that the pupil would have to fill with ink following

carefully the path formed by the pattern, or different types of horizontal, vertical and diagonal lines constituting a scaffold allowing the young writer to get an exact calligraphy through repetition. Most of these inventions insisted on the importance of hand and body posture, thus being techniques and technologies intended to discipline students' bodies.[39] There were also machines devised to print these type of writing guide techniques, a blackboard made of darkened glass allowing to copy different sets of calligraphy placed in the background, or a mechanical spelling machine formed by a turning disc with four concentric rows of letters (from simple letters to three and four letter combinations) with windows displaying letter combinations that changed when turning the disc, and a machine aimed at 'solving any arithmetic problem'.[40]

Some of these inventions targeted several school subjects and advocated for their integrated learning through objects. In 1887, Pomposo Becerril, an artist and teacher who directed the School of Arts and Trades in Toluca, the Mexico state capital, presented an application for a patent on a method for the simultaneous teaching of geography and arithmetic, designed as a board game.[41] Another teacher in the state of Mexico, Clemente Antonio Neve, proposed a school instruction system designed to teach reading, writing, arithmetic, grammar, cosmography, political and physical geography and history through a series of chests of drawers containing three-dimensional coloured letters, numbers and balls, dolls, writing samples, pictures, diagrams, blackboards, square and circular panels and an arrangement of circular tables. Analogously, there were patent applications for encyclopaedic boxes as small chests of drawers containing hundreds of objects (minerals, vegetables, preserved animals or parts of them, woods and industrial products) conceived for object lessons.[42]

Neve is known for his firm advocacy for the teaching method called 'intuitive teaching' or 'objective teaching' which organized teaching through the manipulation of everyday simple objects and the use of the senses by school pupils. For instance, he used rosaries to teach mathematics as a way to materialize arithmetic.[43] He was also the inventor of an 'Intuitive Machine for the teaching in schools', a cube (occupying a volume of one cubic metre) to whose sides were attached different movable figures. Each movable piece (discs or squares) had printed information on is surface and was attached to the cube by poles that allowed their spinning. Some of these discs had also radial metal rods where sets of coloured balls could be placed. According to Neve, working with his machine two hours in the morning and two hours in the afternoon would be enough for adequate school performance. With this mechanical system he planned to teach reading, writing, arithmetic, grammar, geography and cosmography by establishing arithmetic, geometric and chromatic homologies between syllables, numbers and planets with the arrangement of the discs and balls in his machine. Not in vain, in his patent application Neve referred to the logic machine invented by Ramon Lull in the thirteenth century, and it is likely he was inspired by it. He also accused a contemporary competitor of plagiarism: according to him, a machine presented the same month by Antonio P. Castilla with similar aims to his, under the name of 'Caleideslojico' (a combination of 'kaleidoscope' and 'logical') was in fact a copy of an invention well known in the schools of Germany and the US and described for instance in a *Manual of School Material* published in New York in 1874, which he cited. In contrast, his invention was the

result of a thirty-year experience as a teacher, and it had deserved awards in the Agricultural and Mechanical Annual Fair held in St. Louis, Missouri in 1879, and a similar competition in Puebla.[44] Castilla was also a teacher in Mexico City (where Neve had moved and opened a private school) and an active author of patent applications for teaching inventions.

Accusations of plagiarism or lack of novelty were usual in the process of these Mexican patent applications, and in disputes over their originality one of the most usual arguments of competing applicants or patent official reviewers was that the pretended invention had already been invented abroad and copied or adapted by the Mexican applicant. Some patent applications included quite detailed drawings; they were in general figurative (not technical) representations. It appears that the Mexican authorities did not require inventors to deposit at least their invention prototype. As a result, and taking into account that – as far as I know – there are no preserved collections of nineteenth-century educational technologies (including teaching machines) for primary education in Mexico, it is difficult to know if these inventions were actually produced, if they were manufactured in a relevant number, or if they were introduced and used in schools at all.

Historians of the nineteenth-century scientific instrument trade have noted that instrument makers often included in their catalogues reference to instruments that had never been produced, as a way to attract customers by displaying an encyclopaedic repertoire of available products.[45] Historians of technology have demonstrated that patent applications were in several ways literary constructions aimed at protecting for as long as possible inventor's rights, discarding competitors, recovering investments and claiming profit over future inventions based on similar scientific or technological mechanisms.[46] The educational technologies presented in this section were technically rudimentary, both in design, materials and production, and possibly they were produced in small numbers. In the same period, in Europe, countries such as France and Germany were producing scientific instruments for primary and secondary education in large workshops which not only catered for national demand, but were massively exported abroad to other European countries, the Latin American republics and North America, among others.[47] In spite of what appears to be a much more modest production, both qualitatively and quantitatively,[48] the Mexican patent documents presented here are extremely valuable since they can show how Mexican teachers, mechanics and traders saw pedagogical innovation for the improvement of national school education, what their horizons were, and how they conceived teaching and learning. Moreover, through these patents we can investigate the expectations of technification and technologization of education and the ideas on what a teaching machine should be, in a Latin American country such as Mexico, during the second half of the nineteenth century.

AUDIO-VISUAL AND MASS COMMUNICATION MEDIA FOR EDUCATION

In the course of the nineteenth century, new technologies progressively found their way into Latin American classrooms through the initiatives of teachers, inventors, traders and governments. The machines and techniques that they imagined and

designed were grounded in particular pedagogical philosophies (such as object lessons and experimental physics demonstrations). Thus, they contributed to definitions of educational technology related but different to those arising in the twentieth century that I presented in the first section of this paper.

By the mid-twentieth century the use of audio-visual and mass communication media for teaching were on the rise through a more massive distribution of educational technologies in schools, and efforts to standardize their use that contributed to diversification and specialization of teaching practices. In Mexico, Roberto Moreno García and María de la Luz López Ortiz, two teachers and professors at the national teacher training school and the faculty of philosophy and letters of the Universidad Nacional Autónoma de México (UNAM), published an important manual on audio-visual education synthesizing their experiences.[49] Its preface opened with a controversial claim:

> Film projection, applied with anarchy and lack of pedagogical systematization is one of the greatest evils that are currently threatening our national educational system.

The authors compared the risks of contemporary enthusiasm for film projection in schools with the advent of the printing press in the sixteenth century that initially had turned teaching into a bookish practice. The problem was defined as follows: films and slides had arrived in large amounts to schools because of their affordable prices, promoting the belief that all school subjects could be taught exclusively through their projection, and discarding other relevant teaching tools. Retrospectively films had occupied the privileged space that once books had, and the idea that teaching equalled technical mastery of projection machines was becoming established.[50] We can see here the charismatic status that new educational technologies often take.[51] The authors reminded that no more than 20 per cent of the more than 20,000 schools in Mexico had electricity supply. Only a very limited number of schools would be able to use these new educational technologies. Moreover, it was a mistake to think that mechanical apparatus could substitute teachers' action. Without denying their interest, teaching involved a wider range of techniques and technologies within a long history of educational experience, including models, blackboards, charts, school field trips (to nature, the city, or museums), graphic materials, drama representations, clubs, a long repertoire of audio-visual projection techniques, scientific instruments, radio and television.

Their manual provided a description of more than one hundred such materials and stressed their inscription in the framework of several pedagogical philosophies and techniques that should guide teaching practice, organized in five classes that they entitled 'Mexico Classification'. Furthermore, it displayed empirical data on educational technologies and teaching practice surveys carried forward in Mexico, and a good knowledge of international developments.[52] In 1951, Moreno had established a Service of Audiovisual Education at UNAM, and through different executive positions in the national school system he developed a sustained programme for the training of teachers as a way to produce a rational and efficient introduction of educational technologies in Mexican schools. For this purpose a good knowledge of pedagogical foundations and techniques was mandatory, in

order to avoid improvisation and to subdue the economic interests of the educational technology marketplace to school needs.[53]

Although a good amount of the new educational technologies (e.g. films and their projection apparatus) were still imported, during the second half of the twentieth century there was a rising Latin American production of audio-visual and mass communication media for education. Countries such as Mexico, Brazil, Argentina and Chile had started to produce educational films since the 1920s.[54] Moreover, since the 1930s, Colombia, Argentina, Uruguay and Venezuela had national educational radio networks.[55] The first national radio networks in Latin America were created with a cultural and educational goal, and they originally broadcasted specially designed educational programmes. These pioneer radio stations were called in some of these countries 'schools of the air'.[56]

The experience of these educational networks inspired the establishment of television broadcasting between the 1950s and 1960s in all Latin American countries.[57] Countries such as Colombia were offering in the 1960s teaching through television on selected primary school subjects. Colombian broadcasters received technical support from US agencies. In the same period the Organization of American States agreed the creation of a Latin American Television Centre to train educational television professionals, with headquarters in Colombia, Mexico, Chile and Argentina. The development of educational television over large territories also involved technical challenges such as the establishment of terrestrial or satellite networks.[58] Educational television and radio have survived until our days especially in support of education in rural areas in Latin American countries.[59] However, their history displays more ruptures than continuities, since many projects were ephemeral and ended after several years for financial, technical or political problems.[60]

In spite of the difficulties to establish stable platforms for the production of educational technologies in Latin America, there were countries such as Mexico, Chile and Brazil that developed relevant experiences in the training of teachers from across the continent and the production of pedagogical packages. Through agreements with UNESCO a Latin American institute of educational cinematography was established in Mexico (1956),[61] a Latin American mission on audio-visual aids in Chile (1960s),[62] and a project producing science teaching educational technologies in Brazil (1950s to 1970s). UNESCO's Latin American experience was subsequently exported to other parts of the world. The Brazilian project was an exemplary experience, originally starting in university laboratories where science kits were produced for some schools in the São Paulo state, subsequently moving to factory premises in order to expand production to the nation's schools, and finally broadening its production to the medical technology market.[63] These projects were not only national but constituted poles of educational production and training across the Latin American region.

CONCLUSIONS

Computers, tablets and online platforms are invading the way we think and practice teaching and learning, as inevitable references in government policies for educational improvement, and international discourses of socio-economic development. The

degree to which the idea of education has been technified and technologized, and educational technology features in the public arena is perhaps unprecedented. Nonetheless, electronic machines are just one type of educational technologies among a large set of technological objects designed for educational action since at least the nineteenth century. With hindsight, we can see that most new educational technologies were endowed at the time of their introduction with a charisma that contributes to obscure the substance of their contribution to teaching and learning. In spite of the escalating technologization of our society and the undeniable power of educational technologies, a historical and sociological analysis demonstrates that education is still in the hands of human teachers whose practice is shaped by socio-cultural features connected to geopolitical location. Technologies per se would be unable to perform education and to produce educational change. While this might be obvious for historians of technology and Science and Technology Studies scholars, it is still a relevant point to raise towards education scholars and policy makers, and overall to claim the need to historicize educational technology and its practices.

In the twenty-first century Latin America is a privileged field for the trial and commercialization of new educational technologies, and as we have seen, this has been the case since at least the nineteenth century. The importation of teaching instruments, machines and techniques was common in the nineteenth century and it went on during the twentieth century. Moreover, as this paper suggests since the nineteenth century Latin America has also produced educational technology inventions, transformative appropriations of imported technologies, and significant international experiences in pedagogical innovation. While we move towards the inflexible implementation of 'global' educational quality indicators, the techno-pedagogical inventiveness of teachers such as Antonio Neve, the participation of Brazilian researchers in the development of programmed instruction and school science kit design, or the experience of Mexican, Brazilian, Argentinian and Colombian teams in the development of educational radio, cinema, and television, are relevant landmarks to pinpoint.

In contrast to the restrictive definition that characterizes common understandings of ICT for education today, there were particular definitions of educational technology in different historical periods. In nineteenth-century Mexico, printed materials, writing, reading and counting techniques and tools, and encyclopaedic boxes, could be arranged together with teaching machines which developed pedagogical sequences in the classroom. Between the 1920s and 1960s in Latin America, the rise of cinema, radio and television, and the growth and diversification of technologies of image projection opened the way to new terms and meanings such as audio-visual aids and mass communication media. Between the 1960s and 1970s, the production of pedagogical packages for science teaching in Brazil contributed to the conception of educational technology as a kit integrating many – if not all – of the elements previously mentioned in a different pedagogical framework.

In parallel, the production of educational technologies from the nineteenth century to our days has seen major changes such as the move from the solitary inventor to large and interdisciplinary teams, the technification and specialization in educational technology design, commercialization and teaching manipulation, and its role in the institutionalization and professionalization of educational research.

Our discussion of textbooks as technologies and programmed instruction in the context of Brazilian educational research in the 1960s to 1970s, and on the textual qualities of nineteenth-century Mexican teaching machines, are illustrative examples of these trends. As I have argued in this paper, the research objects that I have empirically defined as educational technologies (from textbooks to computers) and the historical phenomena in which they are inscribed, require an integrated approach considering their historically nuanced technological and pedagogical diversity, but dealing with them as a whole. In this context, Latin America features prominently for the historical and contemporary relevance of its educational technology experiences and the great potential of case studies in this geopolitical region of the world. This research agenda requires collaboration between a wide range of disciplines interested in educational practice as a research field, and thus it constitutes a great opportunity for future research in the history of technology.

NOTES AND REFERENCES

1. See for instance Ministerio de Educación Nacional, *Revolución educativa: Plan sectorial 2006-2010. Documento nº8* (Bogotá: República de Colombia, 2008); Gobierno de la República. *Plan nacional de desarrollo 2013–2018* (México: Gobierno de la República. Estados Unidos Mexicanos, 2013); Obama, Barack, '47 – Address Before a Joint Session of the Congress on the State of the Union', *The American Presidency Project* (25 January 2011), http://www.presidency.ucsb.edu/ws/?pid=88928 (accessed 26 March 2018).
2. Sociedade Brasileira de Física, *Atas do Simpósio Nacional de Ensino da Física-janeiro 1970. Edição preliminar* (São Paulo: Sociedad Brasileira de Física, 1970).
3. Beatriz Alvarenga in *Atas do Simpósio Nacional de Ensino da Física*: I-9.
4. Antonio Teixeira in *Atas do Simpósio Nacional de Ensino da Física*: I-22-23. All translations from Portuguese and Spanish into English are by the author of this paper.
5. Josep Simon, 'The Transnational Physical Science Study Committee: The Evolving Nation in the World of Science and Education (1945–1975)', in John Krige (ed.), *How Knowledge Moves: Writing the Transnational History of Science and Technology* (Chicago: University of Chicago Press, 2019): 308–342.
6. John Hedley Brooke, 'Introduction: The Study of Chemical Textbooks', in Anders Lundgren and Bernadette Bensaude-Vincent (eds.), *Communicating Chemistry: Textbooks and Their Audiences, 1789-1939* (Canton, MA: Science History Publications, 2000): 1–18; Josep Simon, 'Textbooks', in Bernard Lightman (ed.), *A Companion to the History of Science* (Chichester: Wiley-Blackwell, 2016): 400–413.
7. Uri Haber-Schaim, 'PSSC PHYSICS: A Personal Perspective', in *PSSC: 50 Years Later* (American Association of Physics Teachers, 2006) http://www.compadre.org/portal/pssc/pssc.cfm?view=title (accessed 26/03/18).
8. John L. Rudolph, *Scientists in the Classroom: the Cold War Reconstruction of American Science Education* (New York: Palgrave, 2002); Simon, 'The Transnational Physical Science Study Committee'.

9. These were produced in Brazil (1962–1964) and Colombia (1964). An earlier translation into Spanish of the main PSSC textbook was published in Spain (1962) by a publisher with branches in many Latin American capitals. This edition circulated widely in all Latin American countries, except Colombia.
10. PLATO (Programmed Logic for Automatic Teaching Operations) was actually designed and run at the University of Illinois, but also used at MIT. Educational Services Inc, 'Records, 1956-1970', MC 79, Box 11; Folder 'Eliza', Records of the Physical Science Study Committee, MC.626, Box 7; Folders 'NSF Comp. in Educ. 12/7/67 Md.' and 'Computer-Aided Displays Proposal', and Roger L. Johnson, 'The Use of Programmed Learning and Computer-Based Instruction Techniques to Teach Electrical Engineering Network Analysis', Report R-297, July, 1966 (Urbana, IL: Coordinated Science Laboratory, University of Illinois, 1968), and D. L. Bitzer, E. R. Lyman and J. R. Suchman, 'REPLAB. A Study in Scientific Inquiry using the PLATO System', Report R-260, December, 1965 (Urbana, IL: Coordinated Science Laboratory, University of Illinois, 1965), Records of the Physical Science Study Committee, MC.626, Box 10, MIT, Institute Archives and Special Collections.
11. MIT Media Lab was created in the 1980s, based on the Architecture Machine Group created by Negroponte in 1967. The OLPC OX laptop was released in the twenty-first century, but it synthesized the ideas on machines and education developed by Papert since at least the 1960s. Morgan G. Ames and Daniela K. Rosner, 'From drills to laptops: designing modern childhood imaginaries', *Information, Communication & Society* 17, 3 (2014): 357–370.
12. Fuad D. Saad, *Análise do projeto FAI – Uma proposta de um curso de física auto-instrutivo para o 2° grau* (São Paulo: Universidade de São Paulo, 1977); Idely Garcia Rodrigues and Ernst W. Hamburger, *O "Grupo de Ensino" do IFUSP: histórico e atividades. Publicações. IFUSP/P-1035, Março/1993* (São Paulo: Instituto de Física – Universidade de São Paulo, 1993); Roberto Nardi, 'Memórias da educação em ciências no Brasil: a pesquisa em ensino de física', *Investigações em Ensino de Ciências* 10, 1 (2005): 63–101.
13. Simon, 'The Transnational Physical Science Study Committee'.
14. Fred S. Keller, 'Engineering personalized instruction in the classroom', *Revista Interamericana de Psicología* 1, 3 (1967): 189–197.
15. Historians of computing in Latin America have remarked Brazilian leadership in the development of a national computer industry between the 1960s and early 1990s. But they hardly make any mention to the market of computers for formal education. Ivan da Costa Marques (ed.), 'History of Computing in Latin America', *IEEE Annals of the History of Computing* 37, 4 (2015): 10–86.
16. Dirceu Soares, 'Êles não estão brincando', *Realidade* 33, December (1968): 202–216.
17. Edward Hamilton and Andrew Feenberg, 'Alternative rationalisations and ambivalent futures: A critical history of online education', in Andrew Feenberg and Norm Friesen (eds.), *(Re)Inventing the Internet: Critical Case Studies* (Rotterdam: Sense Publishers, 2012): 43–70.

18. A large amount of the educational papers on this topic reproduce the propagandist statements of One Laptop per Child's leader, or the Computers for Schools website official statements, instead of analysing the real impact of these programmes.
19. Anita S. Chan, 'Balancing Design: OLPC Engineers and ICT Translations at the Periphery', in Eden Medina, Ivan da Costa Marques and Christina Holmes (eds.), *Beyond Imported Magic: Essays on Science, Technology and Society in Latin America* (Cambridge, MA: MIT Press, 2014): 181–206.
20. In concordance with this view the general argument of David Edgerton, *The Shock of the Old: Technology and Global History science 1900* (London: Profile Books, 2006), and Nelly Oudshoorn and Trevor Pinch, *How Users Matter: The Co-Construction of Users and Technologies* (Cambridge, MA: MIT Press, 2003).
21. Morgan G. Ames, 'Translating Magic: The Charisma of One Laptop per Child's XO Laptop in Paraguay', in Medina et al., *Beyond Imported Magic*: 207–224.
22. María Belén Albornoz, Mónica Bustamante Salamanca and Javier Jiménez Becerra, *Computadores y cajas negras*, (Quito: Flacso Ecuador, 2012). This work in addition includes a concise review of contemporary projects in other countries such as Costa Rica, Chile, Argentina, Uruguay, Brazil, Mexico and Colombia.
23. Hamilton and Feenberg, 'Alternative rationalisations and ambivalent futures'.
24. James A. Levin and Yaakov Kareev, 'Personal Computers and Education 1980, 1984', in Zenon W. Pylyshyn and Liam Bannon (eds.), *Perspectives on the Computer Revolution* (Norwood: Ablex Publishing Corporation, 1989, 2nd edn): 369–393.
25. This approach is partially supported by proposals such as R. Murray Thomas, 'The Nature of Educational Technology', in R. Murray Thomas and Victor Kobayashi, *Educational Technology – Its Creation, Development and Cross-Cultural Transfer* (Oxford: Pergamon Press, 1987): 1–23; Neil Selwyn, *Education and Technology: Key Issues and Debates* (London: Continuum, 2011); Keri Facer, *Learning Futures: Education, Technology and Social Change* (London: Routledge, 2011); Bill Ferster, *Teaching Machines: Learning from the Intersection of Education and Technology* (Batimore: Johns Hopkins University Press, 2014).
26. Eugenia Roldán Vera, *The British Book Trade and Spanish American Independence. Education and Knowledge Transmission in Transcontinental Perspective* (Aldershot: Ashgate, 2003).
27. Lorenza Villa Lever, *Cincuenta años de la Comisión Nacional de los Libros de Texto Gratuitos: cambios y permanencias en la educación mexicana* (México: Comisión Nacional de los Libros de Texto Gratuitos, 2009); Aníbal Bragança and Márcia Abreu (eds.), *Impresso no Brasil: Dois séculos de livros brasileiros* (São Paulo: UNESP, 2008); Laurence Hallewell, *O livro no Brasil: sua história* (São Paulo: EdUSP, 2005).
28. Gabriela Ossenbach Sauter and José Miguel Somoza Rodríguez (eds.), *Los manuales escolares como fuente para la historia de la educación en América Latina* (Madrid: UNED, 2001). For textbooks as a general object of research, see Simon, 'Textbooks', and, 'Physics Textbooks and Textbook Physics in the Nineteenth and Twentieth Centuries', in Jed Z. Buchwald and Robert Fox (eds.), *The Oxford Handbook of the History of Physics* (Oxford: Oxford University Press, 2013): 651–678; Josep Simon

and Antonio García-Belmar, 'Education and textbooks', *Technology and Culture*, 57, 4 (2016): 940–950.

29. Martin Lawn and Ian Grosvenor (eds.), *Materialities of Schooling: design, technology, objects, routines* (Oxford: Symposium Books, 2005); Paulí Dávila and José M. Anaya (eds.), *Espacios y patrimonio histórico-educativo* (Donostia: Erein, 2016). For illustrative examples of history of science approaches to this topic see José R. Bertomeu Sánchez and Antonio García Belmar, *Abriendo las Cajas Negras: Instrumentos Científicos de la Universidad de Valencia* (València: Universitat de València, 2002); Peter Heering and Roland Witje, *Learning by Doing: Experiments and Instruments in the History of Science Teaching* (Stuttgart: Franz Steiner Verlag, 2011).
30. Luis Rubén Pérez Pinzón, *Historia del Empresarismo en el nororiente de Colombia. Tomo 3* (Colombia: The autor, 2015): 79, 84–87, 130, 148–149, 196–197.
31. Josefina Granja Castro, *Métodos, aparatos máquinas para la enseñanza en México en el siglo XIX: Imaginarios y saberes populares* (Barcelona – México: Ediciones Pomares, 2004): 31–34.
32. Rosa F. de Souza, 'Objects of learning: the pedagogic and material renovation of elementary school in Brazil, in the 20th century', *Educar Em Revista* 49, jul./set. (2013): 103–120.
33. Susana V. García 'Museos escolares, colecciones y la enseñanza elemental de las ciencias naturales en la Argentina de fines del siglo XIX', *História, Ciências, Saúde – Manguinhos* 14, 1 (2007): 173–196.
34. In 2013 I catalogued the extant science collections of the oldest secondary school in Mexico City, affiliated to the Universidad Nacional Autónoma de México, with the collaboration of Felipe León. They comprised more than 500 physics instruments and some chemical products, mathematical instruments and experimental physiology and psychology instruments, produced between the nineteenth and early twentieth centuries, mostly by French, British and German makers but also some local artisans. The catalogue was not published and the project could not continue for lack of interest of the Secretaría de Difusión Cultural de la Escuela Nacional Preparatoria. In Mexico there are preserved physics and chemistry teaching collections at the universities of Zacatecas, Puebla and the state of Mexico. For Argentina and Brazil, see María C. von Reichenbach, 'Historic instruments for the teaching of Physics: a chronology of the situation in Argentina', *Museologia E Patrimônio* 8, 2 (2015): 123–142; Marcus Granato and Marta Lourenço, *Coleções científicas de instituições luso-brasileiras: Patrimônio a ser Descoberto* (Rio de Janeiro: MAST/MCT, 2010).
35. Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 27–39. On the difference between privileges and patents see Mario Biagioli, 'Patent Republic: Representing Inventions, Constructing Rights and Authors', *Social Research* 73, 4 (2006): 1129–1172.
36. The two archival series used here are arguably incomplete, but in addition, there is a larger amount of primary sources that would allow building a larger set of patent records. Edward Beatty, 'Patents and technological change in late industrialization: Nineteenth-century Mexico in comparative context', *History of Technology* 24, 2 (2002): 121–150.

37. See for instance, Juan Ignacio Campa Navarro, 'Patentes y desenvolvimiento tecnológico en México: Un estudio comparativo entre la época de industrialización proteccionista y el régimen de apertura', *América Latina En La Historia Económica* (2017), DOI: 10.18232/alhe.789; Edward Beatty and Patrício Sáiz, 'Propiedad industrial, patentes e inversión en tecnología en España y México (1820-1914)', in Rafael Dobado, Aurora Gómez Galvarriato and Graciela Márquez (eds.), *México y España ¿historias económicas paralelas?* (México: Fondo de Cultura Económica, 2007): 425–467; Carolyn C. Cooper (ed.), 'Patents and Invention', *Technology and Culture* 32, 4 (1991): 837–1093; Robert Fox, *Technological Change: Methods and Themes in the History of Technology* (Abingdon: Routledge, 2004).
38. In contrast with the patenting of industrial technologies in the same period, largely due to foreign entrepreneurs. Beatty and Sáiz, 'Propiedad industrial, patentes e inversión en tecnología'.
39. 'Método de escribir de Castillo' (1858), 'Método de escribir Murguía' (1858), 'Nuevo Método para enseñar a escribir letra inglesa' (1858), 'El copiador popular de Antonio P. Castilla' (1870), in Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 53–65. On technique, training and body discipline see Peter Dear, 'A Mechanical Microcosm: Bodily Passions, Good Manners, and Cartesian Mechanism', in Christopher Lawrence and Steven Shapin (eds.), *Science Incarnate. Historical Embodiments of Natural Knowledge* (Chicago: University of Chicago Press, 1998): 5–82; Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics* (Chicago: Chicago University Press, 2003).
40. 'Máquina para estacigencias de escritura' (1869), 'Pizarras calcantes' (1877), 'Aparato para enseñar a leer, llamado "Silabario Mecánico". Autor: Valeriano Lara' (1881), 'Máquina para resolver cualquier problema aritmético, llamada "Contador infalible"' (1857), in Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 66–73.
41. 'Método práctico recreativo para aprender simultáneamente la geografía y la artimética' (1887), in Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 74–83.
42. 'Sistema de enseñanza en las escuelas. Autor: Clemente A. Neve' (1875), 'Caja enciclopédica para la enseñanza intuitiva. Autor: Ildefonso Estrada y Zenea' (1878), in Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 88–99, 116–121.
43. Mílada Bazant, 'La mística del trabajo y el progreso en las aulas escolares, 1874-1911', in Alícia Civera Cerezedo (ed.), *Experiencias educativas en el Estado de México. Un recorrido histórico* (México: FOEM – El Colegio Mexiquense, 2013): 131–150.
44. 'Sistema de enseñanza en las escuelas. Autor: Clemente A. Neve' (1875), 'Caja enciclopédica para la enseñanza intuitiva. Autor: Ildefonso Estrada y Zenea' (1878), in Granja Castro, *Métodos, aparatos máquinas para la enseñanza*: 100–107.
45. Paolo Brenni, 'Nineteenth Century Scientific Instrument Advertising', *Nuncius* 17 (2002): 497–514.
46. Charles Bazerman, *The Languages of Edison's Light* (Cambridge, MA: MIT Press, 1999); Greg Myers, 'From Discovery to Invention: The Writing and Rewriting of Two Patents', *Social Studies of Science* 25, 1 (1995): 57–105.

47. Paolo Brenni, 'The Evolution of Teaching Instruments and Their Use Between 1800 and 1930', *Science & Education* 21, 2 (2012): 191–226.
48. This appears from the analysis of educational technology patents that I have performed here. However, the historical study of the production, circulation and use of educational technologies in Latin America is still a much understudied research area.
49. Roberto Moreno y García and María de la Luz López Ortiz, *La enseñanza audiovisual* (México: Editorial Patria S. A, 1952).
50. Moreno y García and López Ortiz, 'Prólogo de la primera edición', in *La enseñanza audiovisual* (2nd edn, 1960): 7–9.
51. Ames and Rosner, 'From drills to laptops'.
52. Moreno y García and López Ortiz, *La enseñanza audiovisual* (2nd ed., 1960).
53. Libertad Menéndez Menéndez, 'Roberto Moreno y García', in Facultad de Filosofía y Letras (ed.), *Setenta años de la Facultad de Filosofía y Letras* (México DF: Universidad Nacional Autónoma de México, 1994): 443–444.
54. Rosa M. Gudiño Cejudo, 'Un recorrido filmográfico por la Secretaría de Educación Pública: México (1920–1940), *Revista Tempos E Espaços Em Educação* 11, 26 (2018): 91–112; Sheila Schvarzman, *Humberto Mauro e as imagens do Brasil* (Sao Paulo: UNESP, 2004); Alicia Alted Vigil and Susana Sel (eds.), *Cine educativo y científico en España, Argentina y Uruguay* (Madrid: Editorial Universitaria Ramon Areces, 2016); Armando Rojas Castro (ed.), *Cine Educativo. Boletín Quincenal del Instituto de Cinematografía Educativa de la Universidad de Chile* 2, 15 de junio (1932): 1–4.
55. Moreno y García and López Ortiz, *La enseñanza audiovisual* (2nd edn, 1960): 218–219.
56. Milcíades Vizcaíno, *Estado y medios masivos para la educación en Colombia (1929–2004)* (Bogotá: Universidad Cooperativa de Colombia, 2014); Christina Ehrick, *Radio and the Gendered Soundscape: Women and Broadcasting in Argentina and Uruguay, 1930–1950* (Cambridge: Cambridge University Press, 2015); Ayder Berrio et al., *Radio Sutatenza: una revolución cultural en el campo colombiano (1947–1994)* (Bogotá: Banco de la República, 2017); Eugenia Roldán Vera, 'Los orígenes de la radio educativa en México y Alemania: 1924–1935', *Revista Mexicana de Investigación Educativa* 14, 40 (2008): 13–41.
57. John M. Culkin, 'Televisión educativa en América Latina', *La Educación en América* 11, enero-marzo (1963): 57–65.
58. William Bollay, 'Advanced Technological Approaches to Education', in *Report of the Colombia-U.S. Workshop on Science and Technology in Development, Fusagasugá, Colombia, February 26 – March 1, 1968* (Washington D.C.: National Academy of Sciences in Cooperation with the Colombian Ministry of Education, 1969): 30–32; Vizcaíno, *Estado y medios masivos*: 272–291.
59. Dorothy Tanck de Estrada (ed.), *Historia mínima de la educación en México* (México DF: El Colegio de México, 2010).
60. Vizcaíno, *Estado y medios masivos*.

61. UNESCO, *Regional Seminar on the Use of Visual Aids in Adult and School Education in Latin America. Mexico, 28 September – 17 October 1959. Final Report* (Paris: UNESCO, 1960).
62. J. D. Kimball, *Audiovisual aids. Improving productivity of the first nine years of schooling. 1964, 1965. End of mission, January, 1966. Chile* (Paris: UNESCO, 1966).
63. Antônio C. Souza de Abrantes, *Ciência, Educaçao e Sociedade: O caso do Instituto Brasileiro de Educaçao, Ciência e Cultura (IBECC) e da Fundaçao Brasileira de Ensino de Ciências (FUNBEC)* (Rio de Janeiro: Casa de Oswaldo Cruz – Fiocruz, 2008); Simon, 'The Transnational Physical Science Study Committee'.