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Textbooks and educational resources: overview of contemporary research

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Abstract

The text presents an overview of textbooks and educational resources, from inert text to reactive text to augmented reality, taking up the notion of pedagogical text. Then, it presents what can be learned from the cycle described by Larry Cuban of educational technologies in school systems (1986), which is still relevant today. The last part proposes current and future research paths related to the notion of educational resources, taking into account digital technologies and platforms.

Keywords: Educational resources, Cuban's cycle, educational platforms, research perspectives.

Introduction

Teaching and learning may be considered as instrumented social activities:

1. *activities* such as listening, reading, writing, summarizing, discussing... during which learning takes place.
2. *social* with peers, teachers, tutors, parents, because according to Philippe Carré (2005), 'We always learn alone, but never without others.
3. *instrumented*, because purely oral transmission, without support, without written record and exercises, is largely insufficient.

Reflecting on these instrumentations – whether they are supports for experiments in science, mirrors to observe one’s own movements (for example in dance), pens for writing, calculation tools, etc. – is at the heart of IARTEM.

Using instruments for teaching and learning is a very old story. See for example the teaching machines and teaching aids in the Ancient World (Buck, 1989), designed by Hero of Alexandria to show how stationary air could support a sphere or for demonstrating the power of *pneuma*. Numerous and very diverse technologies have been mobilised in education over the centuries. One French example is the praxinoscope, invented by a teacher, Émile Reynaud, in 1876. Patented in 1877, it was an optical toy giving the illusion of movement and operating on the principle of optical compensation. We may mention the magic lantern and others (*Magic Lantern and Lantern Slide Catalog Collection*¹). According to Saettler (1968), the number of patents for teaching machines in the United States has been impressive, and the 20th century saw the production of many machines, particularly around programmed teaching (Bruillard, 2019). With digital technology, the introduction of reactive texts has renewed educational offerings. What is called digital leads to many transformations: new instruments, new ways of producing educational resources, new ways of circulation for these resources... One may argue that changing instruments is like changing schools, towards new forms of schooling (see Collins and Halverson, 2009). In this text, we will begin to look at the textbook, one of the most emblematic instruments in the history of schools and see how its evolution can be rethought right up to the current platforms that are emblems of the new economy of the 21st century and their impact on education. We will rely on Larry Cuban’s famous analyses, and the cycle that he brilliantly described in his 1986 book *Teachers and Machines*. Then we will describe a series of research paths in the domain of textbooks, education media and resources.

School textbooks: basic instruments of education

A textbook is neither just subject content, nor pedagogy, nor literature, nor information, nor morals nor politics. It is the freebooter of public information, operating in the gray zone between community and home, science and propaganda, special subject and general education, adult and child. (Johnsen, 1993, chap 6, conclusion)

The main instrument used in schools is the textbook. A key element of teaching over the last two centuries, widely criticized by many proponents of ‘lively’ learning (or active pedagogy), it is above all an instrument. Even if it is often not seen as such, it is fully naturalized in the practices of the school world.

An instrument is two things: both a sensor and an effector. It is a tool, an extension of the hand, which allows us to act on the world. It is also an instrument itself, in the sense that science advances with its instruments, something that makes it possible to perceive, see and retrieve data and thus better understand the world.

¹ <https://mediahistoryproject.org/magiclantern/index.html>

School textbooks are no exception to this duality. As tools for learning and teaching, they also give us a chance to see the world. Studying textbooks means looking at different characteristics such as readability, material formatting, ‘content’, but also ideologies, stereotypes, relationships of domination, and underlying political intentions. We cannot separate educational and political issues.

Textbooks have a kind of authority and contribute to the socialization of children: ‘They explicitly convey an understanding of history and a vision of the world, as well as models of social behavior, norms and values’ (Crawford, 2000).

For IARTEM researchers, and particularly for historians, there is an interpretative tradition, focusing on the study of points of view carried by textbooks. Thus, E.B. Johnsen’s notable book is structured in three parts: 1. Ideology in textbooks; 2. The use of textbooks. 3. The development of textbooks. What is interesting in the content is indeed primarily the ideological aspect.

Furthermore,

If school was like an organism, the pedagogic texts would be one of the eyes through which the world was seen. The other eye would be the teacher, his or her knowledge and horizon of understanding. The curriculum, the plans and the traditions of different school-subjects would then be like the basic, neural network. This is but one metaphor for the world of schooling, relating what is counted as knowledge to traditions and texts. (Selander, 2005)

Seen in terms of genres, many pedagogic texts are *ostensive* in character. They point at the world, saying: ‘Look here, this is called ...’

In the broad definition of ‘text’, as used by the researchers at Vestfold University College, a pedagogical text is any kind of physical object that can be used in a pedagogical purpose. This, of course, includes textbooks, but also art materials, costumes used in drama education, or accordion used in music education. But what about a dance floor and the classroom space – are they also ‘pedagogical text’ – or are they rather pedagogical contexts? Could anything used by a teacher in pedagogical purpose become a pedagogical text – disregarding what the pedagogical goals are? For instance, if the purpose of education is to stimulate students’ imagination, could a fairy-tale as well as a non-figurative sculpture, become a pedagogical text?²

This notion of pedagogical text is interesting and productive. It makes it possible to go beyond textbooks to focus on devices that have an educational intent, such as recipe books, or aim to convey information, such as road signs. YouTube tutorials on multiple subjects, to repair a washing machine or to learn a technical gesture, are pedagogical texts that could be studied. This notion of pedagogical text can also be applied to objects and ultimately it extends both to the resources and to the contexts in which they are used (for example Insulander, 2006: The Exhibition as a Multimodal Pedagogical Text). As we recalled in the introduction, many objects are present in schools and training places.

² <http://sculpturingwords.blogspot.com/2011/09/what-is-pedagogical-text.html>

Instruments of reference and common resources in schools

The 19th and 20th century school was mostly based on books and notebooks. It was also based on resources that teachers ‘no longer see’, because they are totally part of their environment. They are available on all media and are produced by all types of organisations (commercial, free, associative, personal...). Typically academic, they are often a legacy of school subjects. They have been in school for a long time, for example:

- the periodic table of elements found on the covers of textbooks, on the website of the Association of Physics and Chemistry Teachers, on a classroom poster, now in software...,
- tables of conjugations of irregular verbs in English,
- trigonometric and multiplication tables that have become pocket calculators in mathematics,
- geographical maps,
- documents of all kinds ...

There are also the usual resources (dictionaries, encyclopedias) that cannot be classified as textbooks, and which are used well beyond the school. The case of tools and instruments is more complex: the compass, ruler, or protractor do not strictly speaking incorporate ‘informational content’ (although they ‘embed’ knowledge). They are essential resources.

The lists and tables that we have just mentioned are typical of book and paper technology, whether displayed on the walls of the classroom or integrated into books and notebooks, and they are also found in different media. Information technology does not only lead to a change of medium (from paper to screen), but to a new type of document that can be described as ‘reactive’, i.e. offering possibilities for interaction and allowing different kinds of processing. The possible activities for students go beyond simple identification (a map) or memorization (a multiplication table). Calculating instruments replace calculation tables, conjugation tables can be applied to selected verbs, geography maps are interactive and can be composed of superimposed layers.

Digital instruments have become commonplace in education. They are central when prescribed programmes (curricula) mention their use. In mathematics, this is the case for dynamic geometry software (e. g. Cabri geometry³ or Geogebra⁴) and spreadsheets. In technical and industrial sciences, the Solidworks⁵ computer-aided 3D design software (REF) is essential. In physics, chemistry and biology, we can mention

³ <http://www.cabri.net/cabri2/introduction-e.php>

⁴ <https://www.geogebra.org/>

⁵ SOLIDWORKS is a proprietary 3D computer-aided design software. <https://www.solidworks.com/fr>

the world of simulators that are often linked to CAex (Computer Assisted Experimentation), such as oscilloscopes, electrical circuit simulators, etc.

Other instruments are now being used in the classroom, for example, online dictionaries or translators. The question also arises about general instruments for recording and processing sound (e.g., the free software Audacity), photography, or moving images. Most of these instruments were not designed for educational purposes, but some have been specifically developed to be used in schools.

There is a tendency to move from inert documents to reactive documents, then to interactive and immersive ones. Does changing the instruments change the school? It is not so simple to answer this question. Social and societal changes, linked to the widespread deployment of digital technology, are certainly the key forces. Thus, a postmodern vision of society is not satisfied with a single discourse but promotes multiple points of view. This may require diversified resources, and the Internet can disseminate diverse offers. This is in contrast to a particular national vision (e.g., the national novel) which seeks legitimacy, particularly through the history that may be found in school textbooks in the past and which may reappear today.

Technologies may also change cultures and practices. Anyway, new technologies regularly appear and their impact on school systems is not as important as is often claimed. The cycle described by Larry Cuban provides an interesting insight.

Larry Cuban's cycles revisited

In his seminal 1986 book, *Teachers and Machines: The Classroom Use of Technology Since 1920*, Larry Cuban presented a cycle describing how a new technology, to be used as an educational technology (see Bruillard & Baron, 2018), is considered in the American education system, a cycle that applies without much change to other education systems.

Those cyclical patterns have accompanied new technologies for nearly a century: reform-minded policymakers surround the innovation with extravagant claims followed by academic studies showing limited or unimaginative classroom use of devices followed by disappointment and then blame heaped upon teachers rather than those who made the initial claims. (Cuban & Jandrić, 2015)

Different elements punctuate this cycle in four stages, from enchantment to disillusionment: promises / scientific validation / disillusionment / limited generalization.

The first stage corresponds to the emergence of a new technology in the social space (radio, cinema, television, computer, etc.). It arouses interest and hope, opening new perspectives. Its adoption is often rapid and its use in education appears obvious. Gurus predict a radically new education, merchants push for big equipment plans, and parents want their children to use these technologies that are seen as technologies of today and tomorrow. Educational authorities hear all these requests, but before prescribing their use in education, they seek guarantees.

The second stage corresponds to the experiments. On the one hand, educational authorities ask ‘science’ to prove that technologies will indeed improve education. On the other hand, innovators embark on classroom uses, engaging students in new activities with these technologies. In both cases, it ‘works’. Science, through laboratory tests, undoubtedly shows that technologies have a very strong educational potential and the achievements of innovators, who are the most visible, are praised in the media. There is no obstacle to what companies call ‘scaling up’.

The third stage is the start of an intended process of wider implementation. What had seemed obvious – the classroom use of technologies with surprising but well-documented powers – now appears rather problematic. The expected benefits are slow to materialize and the uses are rather disappointing. Teachers – who are, in a way, the supporters of an old world – are incriminated as obstacles to the ‘wonderful’ technologies of the new world.

The fourth stage corresponds to the result of the attempted wider implementation. The new technology is used infrequently, only marginally modifying the activities carried out in schools. A different new technology arrives at the front of the stage and a new cycle begins.

The works of Larry Cuban (1986, 2001) explain very well why teachers are caught in contradictory injunctions and why technologies do not keep all the expected promises, without being able to incriminate teachers. Teachers’ role is not to be modern, but to ensure that each student in their care makes effective progress in their learning.

Cuban’s analysis is that of a historian, above all a retrospective one. But, as a great connoisseur of teachers and their work in educational institutions, his analysis attests to rather stable processes that are reproduced with each new wave of technologies. Institutional oversight and amnesia, naivety of parents, cynicism of authorities, strategic importance of the technologies in question, lead to very similar results. There is certainly no curse, but a similar process is observed in new contexts.

Since the early 1990s, several new waves of technological innovation have followed one another: the Internet, Web 2.0, virtual reality, tablets, smartphones, serious games. The latest promises concern artificial intelligence, in fact a new emergence of something that is already old, but now appearing in new times (like a technology). The pace of innovation has accelerated. One would have thought that the knowledge of the cycle that Cuban so well described could have had an influence on the progress of these projects, but this is not really the case. Nevertheless, if we try to rethink what was happening in 2021, even if the underlying general dynamics are fairly stable, some elements of the cycle have changed. We will revisit it, highlighting some new characteristics that illustrate developments, mainly societal, that constrain relations between the actors involved.

First, in the stage of the appearance of a new technology on the scene, relations with the public have changed. Blind belief in improving living conditions through technological progress is no longer so widespread and a certain mistrust has

developed. The accompanying discourse has generally been one of delay: other countries are more advanced, and there is no doubt that this delay must be made up. For parents, it is about teaching their children in today's world, with the technologies that are spreading, and especially not remaining in the past. A positive and mobilizing ambient discourse is replaced by a discourse of resignation, linked to the risk of decline. We are in an international competition that forces us to evolve. It is not a question of catching up, but of avoiding a decline described as inevitable if we do not quickly consider the technology that has just emerged.

The gurus are still present, but some of them have become imprecators of the apocalypse: if you do nothing, you are heading for a fall. Another point is the need to take ethical issues into account. Technology is far from having only positive aspects and it is certainly necessary to protect oneself from potentially harmful aspects (job losses, possible restrictions on freedoms, health risks, addictions, etc.). Ethics acts as a kind of safeguard against the dark aspects of technology and certain modalities of its use. Finally, foresight exercises are multiplying, probably in order to think about the future as far as possible, but also to justify the urgency of decisions to be taken in the present.

For the second stage, focusing on proving that a new technology may improve education is no longer necessary. Basically, this goes without saying. If science still benefits from an aura that allows it to 'sanctify' technology, research changes its function: it becomes a form of companion of this technology. It predicts how to use the technology effectively, putting a kind of seal, offering a guarantee of effectiveness. On the innovators' side, media coverage is increasing. Media show advanced uses of technology with students that give credibility to their educational potential. They then become sort of spokespersons and are responsible for developing and helping to disseminate good practices. Thus, this second step changes in nature: 'science' no longer proves and, above all, no longer explains, that technology is essential. Innovators are associated with pressure groups.

The development of open and participatory science accredits the idea that everyone can experiment directly, try, collect data, and interpret them. Since the technology is automatically 'accepted', we enter an incremental process. This way of using science leads to an articulation between stages 2 and 3, around a sort of change management.

Indeed, what is known as change management now seems to be an essential element. Most teachers will not take direct control of the technologies intended for them. It is then considered necessary to carry out specific support actions in order to convince teachers to change their practices.

The reference, rather implicit, is found in Rogers' diffusion models, with figures of early adopters, resistance fighters, silent majority, etc. For educational authorities and techno fans, it seems almost certain that teachers must be convinced, or even forced. Worse still, science can contribute to the exclusion of teachers, or at least a minimization of their role. Will they have the skills they consider essential to implement science-based technologies? Are they still the essential intermediaries or

can they be partially set aside? In particular, the use of artificial intelligence systems, which require large amounts of data, may require their collection and processing on a scale that is bigger than that of the school, and the analyses carried out may lead to action orders communicated to teachers. We can also think of another cycle around centralized computing in large systems or decentralized in personal devices. Both trends currently coexist with smartphones associated with service platforms.

There was a period in the United States and elsewhere, when publishers and instructional designers wanted to create ‘teacher-proof’ textbooks. These were to be books that would fit into an ‘instructional system’. The teacher was to be programmed to use the books in precisely the way that the authors and editors had designed. [...] Those who examined the effects of these approaches soon learned that the system was far from perfect. Teachers were able to transmute the most teacher-proof texts. Questions that were to stimulate discussion were transmuted into factual recitations. Plans were sabotaged by the very fact of the classroom and its inhabitants. (Purves, 1993).

We are entering stage three (with stage four in a few years). Will not so-called digital technologies lead to a change in the very model of schooling? Various researchers (Collins & Halverson, 2009) thus discuss the transition from an industrial school model to a post-modern model, particularly because of the existence of digital technologies.

Behind the cycle, beyond an educational vision, we must not forget, due to the cost of these technologies, that there is always a strong economic dimension. A country can only embark on a major capital investment plan if it can also see economic interests in it: running its machinery production industry, or its general or sectoral software development sectors, or developing its services (educational games, virtual or augmented reality, etc., tablets and computers, start-ups and software sectors, AI captured by large companies). Above all, this aspect must not be neglected, a constraint that is better integrated when thinking about educational issues.

For example, the UNESCO center called MGIEP is mainly financed by the Government of India, which provides 58% of the total revenue. Additionally, the Institute receives voluntary and in-kind contributions, representing 28% of total revenue. Each year, the Institute also receives contributions from UNESCO, representing 11% of total revenue⁶.

Moreover, for developing countries, there may be an interest on the part of donors and multinationals to impose a technology and make the country’s forces dependent. This can be counterbalanced by a training policy aimed at emancipation and breaking this dependence on proprietary technology. Hence the importance of open policies at all levels.

In any case, we are in the middle of this cycle, and we will see its outcome in a while.

⁶ <https://www.yumpu.com/kiosk/unesco-mgiep/unesco-mgieps-annual-report-2019/63465468>

It should be noted, however, that this cycle corresponds to what we call educational technologies. Digital technology can also play other roles in education (see Bruillard & Baron, 2006; UNESCO 2019, p. 9), such as technology for organisation, communication and information research in the classroom and at home, regardless of what is being taught, or as an instrument at the heart of the disciplines taught. In these cases, the processes of diffusion are completely different (Baron & Bruillard, 2007; Bruillard & Baron, 2018). Initially, educational research helps to develop innovative and interesting uses in the classroom. These can then be taken up and modified through processes of appropriation by teachers and through what we have called *processus de scolarisation* (processes of schooling), enabling the implementation of uses compatible with the constraints of education systems and teachers' working conditions.

Research perspectives

The preceding developments remind us of the importance of textbooks and technologies in school education, but also of the problems they pose, as well as a form of school organisation that is strong enough to resist the deployment of educational technologies that are not adapted or adaptable to the activities carried out by teachers.

What research perspectives may be considered in the vast field of educational resources, given the evolution of social systems and digital technologies?

As we have seen, even if textbooks still have an important place, educational resources in the broadest sense must also be considered. This extends to educational resources the research that has traditionally been carried out on textbooks. According to Alain Choppin (2005), textbooks perform four essential functions: referential (curricular); instrumental; ideological and cultural; documentary. Other resources can have the same roles and it is important to study them.

In particular, the ideological role remains important regarding educational resources. Although digital technology tends to appear neutral, it carries ideologies and stereotypes. Moreover, current digital resources, linked to mobile technologies that some people are constantly using, raise new questions.

We will begin by recalling an old Chinese proverb in order to characterise some research directions, before describing some research paths that seem important to develop by taking up the three axes defined by Johnsen (1993): the textbook as an object, the development of textbooks and educational resources, and the uses of educational resources. We can rephrase these a little differently by using the Instrument–Actors–Systems framework (Baron and Bruillard, 1996). The instruments are implemented by lay people (students), under the direction of teaching professionals who prescribe legitimate and effective methods of use, according to institutional requirements (such as the programme and the curricula). Teaching professionals have views, beliefs and value judgments that guide their actions. In addition, they operate within systems that offer them margins of manoeuvre and constrain their action (Baron

and Bruillard, 1996). We therefore have to consider the interactions between systems, instruments and actors.

How to articulate signs and referents with human mediation?

A well-known ancient Chinese proverb says: *When the sage points at the moon, the fool looks at the finger*. Of course, this proverb has many possible interpretations.

According to Selander (2005), seen in terms of genres, many pedagogical texts are *ostensive*, pointing at the world. In fact, educational media designate the objects of the world, and the way they do so is not free of ideology. Analyzing textbooks can be considered as analyzing the ‘finger’ and is a tradition in IARTEM. It is important to do so, not only from a technical point of view, but also from the point of view of the norms, values and ideologies that they convey. The way things are shown is significant, rarely neutral.

However, Chinese tradition favours another interpretation of this proverb. Huinóng, (638–713) was the sixth and last Patriarch of Chan Buddhism and was reportedly unable to read Chinese or any language. According to the story, he proposed to help one of his colleague monks to understand Mahāparinirvāṇa Sūtra, but his colleague laughed, ‘How can you understand it if you don’t even read?’ Huinóng replied:

Truth has nothing to do with language. Truth is like the moon in the sky and language is like the finger that points to the moon. A finger can point out where the moon is, but the finger is not the truth. You can see the moon without help of any fingers, can you? ^{7 8}

Thus, the means of designation or naming would be secondary, if one could access a truth that transcends the way of formulating it. Our semiotic traditions invite us to see things differently, and our rational traditions lead us to ask for explanations.

Today, technologies such as smartphones respond almost instantaneously, with growing impatience from users who no longer tolerate having to wait for an answer. Since there is no delay between the request and the response, via a technology that many people carry with them almost all the time, we do not see the process of getting that response. We can no longer see the finger, as if no one were there to point. Technologies described as intuitive reinforce this absence. Therefore, this situation invites us to be more vigilant in education: new digital technologies are far from neutral and can be very effective vectors for partisan or even fraudulent aims.

Nevertheless, there is another aspect to be emphasised. Indeed, in the story, Huinóng, from the reading that is made to him, is able to explain sentence by sentence and ‘there is no point that does not correspond to the original meaning of this work’. This underlines the importance of human mediation. Access to the text does not guarantee its comprehension and a human explanation may remain essential.

⁷ <https://www.quora.com/Does-the-saying-When-the-sage-points-at-the-moon-the-fool-looks-at-the-finger-really-have-Chinese-origins>

⁸ See Annex for another translation from a Chinese source: <https://baike.baidu.com/item/指月/3692725>

Technology makes access much easier and very fast, but does not necessarily help to free up the time needed for reading and comprehension. One of the objectives or means of education is precisely to slow down time, in order to become aware of what is around us and not to admit too quickly all that is shown. Hence, the importance of adopting constructive and critical aims.

Textbooks and educational resources contents: objects to be considered

We have already mentioned the main lines of research on textbooks, which can be extended to other educational resources. Many examples can be found in the publications resulting from the various IARTEM colloquia (Rodriguez et al., 2019). In French, many books were published in the 2000s (Lenoir, Rey, Roy, & Lebrun, 2001; Baldner, Baron & Bruillard, 2003; Bruillard, 2005; Mœglin, 2005; Lebrun, 2006).

It can be noted that studies on inequalities (Tisserant & Wagner, 2008), particularly on gender representation in textbooks (Fontani & Paivandi, 2020), continue to be conducted, and more generally on diversity issues. According to Knudsen & Selander (2019), we observe a progressive orientation towards questions of identity: ‘democratic development in relation to issues like nationality, gender, ethnicity and social background’. Reflections focus on the representation of minorities, minority cultures and identities (intersectionality). The notion of ‘otherness’ is discussed ‘in terms of ethnicity, race, the nation, gender, class and religion as well as in relation to majorities and minorities.’ Several IARTEM publications are devoted to this theme (for example, ‘Representations of minorities in textbooks: international comparative perspectives’). See also Castro Rodríguez (2019): ‘25 years of research and reflection on the relation between didactic materials and attention to diversity’.

We will limit ourselves to a more in-depth look at the disciplines (academic or university) and their relationship to educational resources (subject-oriented research).

Some disciplines are highly organised at the international level, with scientific journals, conferences, etc., and can embrace the issue of educational resources. They often adopt a point of view that is their own and depends on the modes of reasoning in that discipline. Mathematics is a good example.

Often the textbooks of a discipline are taken as a corpus to study the teaching of the discipline itself. The book is seen as a culmination and its contents are analysed, away from the teachers. This is less expensive than field surveys, a lot easier, and gives a sometimes idealised view of the discipline. The study of old textbooks allows diachronic analyses, where it is no longer possible to go and investigate in the field.

Apart from the ‘major’ disciplines (mother tongue language, foreign language, geography, history, mathematics, or science), some courses can lead to more open approaches, beyond the school level, particularly around formal and informal education, diverse cultures, etc. Thus, music and the arts allow specific approaches and can constitute a kind of laboratory for a better understanding of phenomena, which we do not see or hardly see in ‘universal’ (with no specific cultural patterns), often high-

stakes disciplines at school, such as physics and mathematics. Thus, we can oppose a single discourse ('universal' disciplines) and a multiplicity of cultural practices, articulating heritage and innovation, living practices to be invented or re-invented.

Thus, the question of notation and recording (reading and writing) arises in forms that are not yet schooled. Writing is not a *déjà là* to be learned: how to code dance movements or sound sequences.

As far as music is concerned, Romanelli (2019) has noted various tensions and contradictions: how to avoid the encyclopedic tradition in the writing of textbooks and how to make it possible to develop efficient teaching practices? What complementarity is there between books and technologies, the latter allowing for multiple experiences? How to go beyond music, visual arts, dance, etc.?

In fact, the question of the link between textbooks and practices is important. In printed manuals, there is a description of the activities to be done. These activities may require everyday objects that are diverted to make music. Digital textbooks can become the very site of the activity. The question may be, what encourages people to do the activities and what ultimately destroys the activities? What allows a collective invention, and what is more oriented towards a purely personal use?

In music, there are places other than the school to learn it and many resources are not managed by the school (Levoine, 2019). In any case, many specificities related to the teaching and learning of music and the educational resources developed and used (see Vicente Álvarez et al., 2019) can inspire research in other areas of specialization: amateur writings in science and history, associations for the practice of science, etc.

Towards better understanding the design, selection, and recommendation of educational resources

With the development of the Internet, the ways in which different countries regulate the selection of educational resources has changed. While many countries used to set up selection committees, leaving the choice to the teachers is increasing (see the GEI database on the different countries⁹). For example, pre-approval commissions were abolished in Norway in the early 2000s. How does the recommendation and then the selection take place: commissions within schools, groups of teachers, individual teachers? Are teachers sufficiently prepared to make the resource selection?

Forms of evaluation and certification of resources (by national authorities, by associations, particularly teachers' associations, by medias and social medias), based on a priori studies or studies of use, will develop. They will be different from the grids designed for selection by educational authorities since they are intended to be used directly by education stakeholders. Apart from the evaluation criteria, different

⁹ <http://www.gei.de/en/departments/digital-information-and-research-infrastructures/edumeres-the-virtual-network-for-international-textbook-research/edudata-textbook-systems-worldwide.html>. Nevertheless, some countries revert to central publishing/selection while others have moved to decentralise.

recommendation systems will be set up. There is a great deal of computer science work on the development of automatic recommendation systems, which should be considered (see for example, Drachsler et al., 2015).

An evolving market

This is changing the market for educational resources, the economic models linked to resources (open educational resources, OER), and the marketing and modes of distribution of educational resources. It changes the design processes themselves (UNESCO, 2019). As a result, new publishers are developing highly collaborative practices. For example, *Le Livre Scolaire*¹⁰ presents itself as producing the first paper and digital textbooks co-created by 3000 teachers. Its publishing model is based on three pillars: collaborative (interactive participation of hundreds of colleagues in the process of textbook production), free (free online textbooks), and digital (textbooks in the form of a website, with additional features such as interactive maps and a mode adapted to dyslexics). The model is based on the sale of paper books and premium digital subscriptions. Authors are remunerated by copyright.

Carton (2019) shows that the ed-tech publishing company *LeWebPédagogique*, while describing itself as a ‘community of teachers’, corresponds to a marketing strategy and economical model. ‘It also epitomizes its capacity to address teachers and to mobilize them to produce school-proof content.’

With several different collections of textbooks under free license at their disposal, large and remote teams may collaborate and design a digital object that can be directly printed. Netado project¹¹, a collection of free textbooks for teaching French in middle and high school, has followed this model. The development time for each of the successive textbooks of the Netado project has decreased significantly as the team has become more experienced and has the benefit of a greater number of textbooks under free license¹². According to Sébastien Hache, they could even adapt the Sprint book processes, that is, to design and produce books in a few days. The open textbook *British Columbia in a Global Context* was written in four days by a small team of geographers and assistants¹³. Other examples can be examined on the Booksprints website¹⁴. Such a process can be useful in adapting textbooks in specific countries and cultures, working with local teachers.

Education resources and quality

The question of the quality of resources is also raised with a traditional opposition between artisanal and industrial approaches. Interesting distinctions between different

¹⁰ <https://www.livrescolaire.fr/>

¹¹ <http://netado.vn>

¹² <https://fr.flossmanuals.net/realiser-des-manuels-sous-licence-libre-retours-dexperiences/draft/v/1.0/preambule/>

¹³ <https://bccampus.ca/2014/06/20/how-to-turn-a-great-idea-into-an-open-textbook-in-just-four-days/>

¹⁴ <https://www.booksprints.net/>

visions of quality have been proposed by Illum Hansen (2019), namely Unique, Traditional, Standardized and Innovative. The transitions from one model to another are far from simple.

Quality can be seen as a property of resources, although different judgments can be made about them (Illum Hansen & Toke Gissel, 2017). Nevertheless, because digital educational resources can easily be modified and exchanged (under certain conditions), quality can result from transformations made by teachers: resources that are initially of poor quality can be improved by successive interventions by teachers. This raises the question of the management of a set of educational resources, seen as Commons in the sense developed by Olstrom (Baron & Zablot, 2017).

Teacher collectives produce educational resources (Beauné et al., 2019) and play an important role in the professionalization of teachers (Lantz-Andersson et al., 2018). Teacher collectives constitute specific spaces for interaction on resources but also for sharing, appropriation and development of original proposals for the design and dissemination of living educational resources.

A few years ago, work was initiated by Mike Horsley in order to develop standards for classroom teaching and learning materials¹⁵. The idea is that the quality of teaching practices and teaching quality emerge from the complex interactions between resources, teachers and schools. ‘In this view, teaching quality reflects not just the qualities of individual teachers and teaching teams, but also the parameters of teachers’ work in their schools’.

Within the framework of an open market, teacher collective resources move away from the model of national management of certified resources. They are found and created, according to their needs, skills and available time, by the teachers themselves. Thus, concepts related to the web and marketing can be interesting, such as discoverability: the potential for a content, product or service to capture the attention of an Internet user in order to make him or her discover other contents. Basically, it is the extent to which something, particularly content or information, can be found by searching in a file, database or other information system.

In fact, although the current situation may have less *a priori* control by educational institutions, other elements (big data and artificial intelligence) can on the contrary reinforce control, leading to an interest in what educational actors do and their use of educational resources *in situ*.

Approaches based on usage: from text to text practices

Indeed, the modes of selection of resources by National Commissions have privileged studies on textbooks as objects, with the study of the criteria they have to comply with.

We also need to consider ‘text *for* learning and text *in* learning: how they are constructed and function in educational settings, and how they function in use’ (Knudsen & Selander, 2019).

¹⁵ See <https://iartem.org/have-your-say/draft/>

First, how the students use educational resources. According to Stanley Fish's article, 'Is There a Text in This Class?', in a classroom there will be as many texts as readers. Aamotsbakken (2019) describes different complementary approaches to adopt for studying texts and their readings by students.

In higher education, Sikorova and colleagues (2020) investigated the ways in which educational resources are studied (approaches described as shallow or deep) and the link to educational outcomes.

Another interesting research direction is to study how students can find help. Faillet (2020) studied secondary students (in biology) and showed that forums are their favorite web application to ask their peers questions about homework: students mainly look for explanations rather than only answers to exercises – this gives added value to their learning experience. Moreover, he found that the use of the social web to ask school-related questions was a rooted practice in certain 'communities' (e.g. homework help websites, scientific or high-tech websites, and video gaming-related websites) for some students (half the questions are asked by students who have already done so multiple times). In addition, we can sometimes notice that school-related questions colonize non-school-related forums (e.g. forums dedicated to horses or firefighting). This reveals that students can pursue a personal interest or passion with the support of peers and can link this interest to academic achievement – a connected learning.

The development of informal learning and connected learning (Ito et al., 2013) also opens up many avenues both in terms of training offers (from simple tutorials to full courses offered on the Internet) and in terms of follow-ups to these offers. The way in which educational texts are offered on the Internet should lead to interesting studies.

The concept map (Figure 1), coming from TWG 7 (Connected learning: online human interaction and interaction with digital resources) of EduSummIT¹⁶, provides a list of important issues linked to connected learning.

Digital technologies are introducing other uses that are now possible or simply facilitated, making it possible to deal with different aspects of schooling. A first example is related to the school climate. How can we take into account how students feel about different tasks and school moments? An application such as *Elevbaro* (Graf & Carlsen, 2017), allows students to declare their feelings with a simple cell phone. It is built on frequent ratings of five set statements in connection with teaching over a certain period. Teachers can retrieve and aggregate their data and consider individually or collectively the statements of their students and the possible difficulties they may encounter during certain activities. According to the authors, the exploration of systematic student feedback is an overlooked topic, and there is didactic potential for teachers' data-informed teaching development.

¹⁶ <https://edusummit2019.fse.ulaval.ca/> See Bruillard et al. (2021).

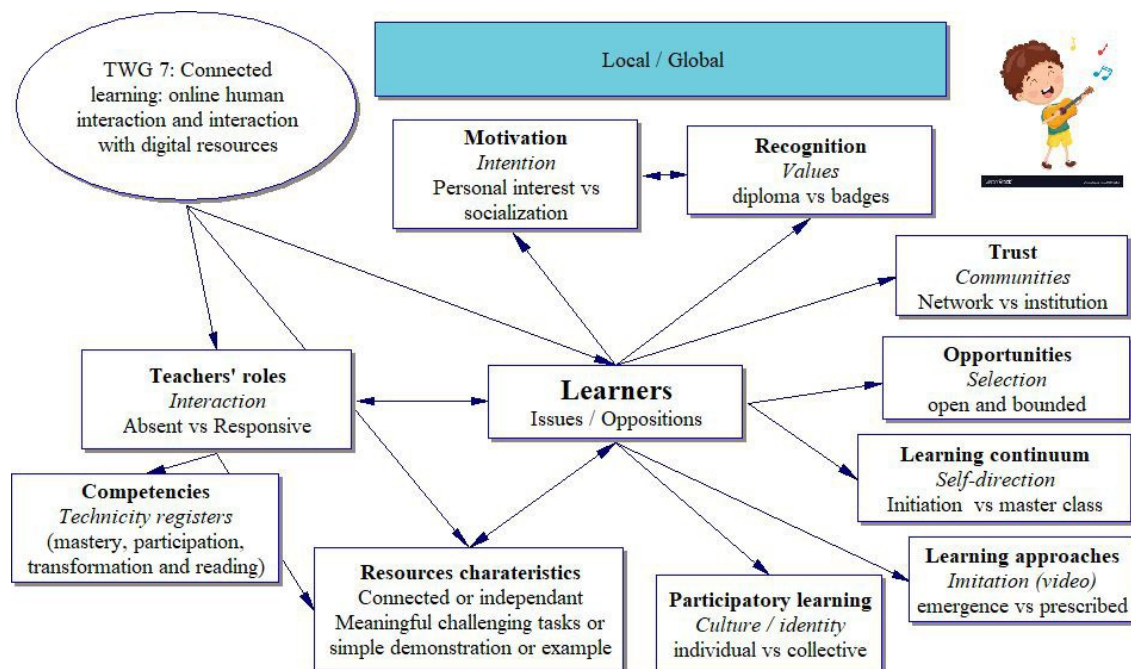


Illustration 1: Synthesizing connected learning. (The design of the map was partly based on the case of learning to play the guitar, which explains the little character at the top right.)

The textbook has always provided a link between school and home. Parents could see in the textbooks what their children were doing at school. Some textbooks included advertisements aimed at parents (D’Avila, 2001). The students’ exercise attested to what was done in class. With the Internet, applications such as Classroom (REF) allow parents to see a lot of things that happen at school. This raises questions about the management of personal data.

Another research direction is connected to teachers and the way they work with educational resources. It has been deeply explored in the ReVEA project (Bruillard, 2019; Loffreda et al., 2017), but there is still a lot to be done. In her thesis, Loffreda (2021) considered the materiality of resources and studied the modes of organization of educational resources. A booklet, developed with a graphic designer, presents in detail three very rich portraits of teachers.

According to Loffreda, the activity of materials organization plays an important role in the process of the appropriation and construction of knowledge: it is through this process that teachers can develop internal resources and thus build and establish their legitimacy as professionals. Etymologically (in French), we can distinguish ‘the resource’, which is rather an internal force (internal capacity), from ‘resources’, which are external means. These means help to renew internal capacities. This leads to two major lines of research: (1) centered on the individual characteristics of people, and how this internal force is constructed and manifests itself; (2) centered on the means, at the individual and collective levels, and interaction between teachers and resources. It can be said that a beginning teacher needs (external) resources, while an experienced teacher has (internal) resources.

Not all technologies, even if they can *a priori* be very useful for learning, are necessarily usable in the classroom. A historical example is that of films. One would think that films would be used extensively in the classroom. Taillibert (2016) shows that it is not the case. Their use in the classroom poses a problem. The teacher must be able to easily adapt and complete the proposed discourse and contextualize it for his/her group of students. To do this, the technology must give him/her a space. The idea was to make freeze frames of certain photographs chosen from the films used. This process allowed teachers to break the filmic continuity by commenting on the most significant elements of the film, which at the same time enhanced their function in the pedagogical process.

It is a question of deconstructing the linearity of viewing imposed by the very nature of the film and literally inventing a new use for the filmic material, fragmented, interrupted, worked on by external comments, dissociated from its initial script. (Taillibert, 2016).

Promoting connected and multi-disciplinary approaches: instruments, actors and systems, international comparisons

Launching research on the relationships between instruments, actors and systems can help to take into account the complexity of the design, circulation and uses of educational resources.

Conducting international comparisons can be productive, which an international association such as IARTEM can certainly facilitate. However, strictly comparative approaches are difficult to implement because of the specificities of different national or regional education systems, making comparisons and interpretations very delicate.

Contrasting approaches, focusing on the differences of elements present in one system and not in another, can lead to productive research. Thus, contexts of abundance and scarcity can be interesting to compare if one wants to study certain problems associated with these contexts. For example, in the case of Madagascar (Ratompomalala & Bruillard, 2019), one might have thought that the context of scarcity would have encouraged teachers to work cooperatively, but local conditions lead them to keep for themselves the educational resources they recover or build. In particular, if they want to supplement their meagre salary by giving private lessons, teachers find themselves in competition with each other. Similar behaviours can also be found in Vietnam, with the practice of keeping documents scarce because of competition between teachers (Nguyen & Bruillard, 2011): the ‘best’ teachers in high schools of excellence are not very inclined to exchange, while teachers in the same school hardly cooperate with each other because they have to be able to show their headmaster what they have personally done. However, cooperation on the Internet is still possible and factors that promote sharing include incentives, having quality, easy-to-use resources, and the presence of trust within teacher groups with access to discussion features in their sharing sites.

Concluding remarks

We have quickly sketched out different avenues of research to be conducted on educational resources. The landscape has changed, and digital technologies are having a significant impact on our lives outside of education. We make no claim to exhaustiveness, and IARTEM's publications, including the book celebrating the association's 25th anniversary (Rodriguez et al., 2017), provide many other directions for research.

I share the point of view of Knudsen & Selander (2019): 'The field as such – textbooks and educational media – is not a coherent field of research, and perhaps should not be'. Nevertheless, some very new changes with digital technology have to be taken into account.

Thus, three characteristic points seem important to me.

The first is the separation between the physical world, the one we live in, and the informational world. The school was the place of learning about this informational world, through reading and writing. With the digital world and the Internet, the physical objects of the world can be endowed with informational 'skills'. Objects can have their own description of themselves and have information that they can exchange. We can interact with them. Thus, what is called virtual reality consists in plunging the user into a universe, to deceive his/her senses, so that he/she has the impression of being in this world and acting in it. Augmented reality is precisely the fact of adding information to the objects of the world. There is no need for a designating system, associating the data with an object that is shown (like the finger pointing to the moon). The user can be engaged and have an experience. One way to be engaged is to act. But is acting learning? Can we learn without words? How can we reflect on the experience?

A second point is also related to the specificities of digital objects. Educational resources not only provide content but can also manage interaction with learners and keep track of this interaction. These data (learning analytics) can then be used. An essential issue is associated with the ways in which these data are collected and processed and the educational decisions they can induce:

- will the machine decide according to algorithms that may or may not explain the reasons for the decisions taken?
- will a national body retrieve all the data in the name of science?
- will the teacher be completely in charge of his class or group of learners?

In the latter case, how can we ensure that the teacher has access to data that are sufficiently well presented for him to interpret them, and that he has the knowledge to choose 'adapted' interventions and the time to be able to interpret the data? Alternatively, ideas of the 'teacher-proof' could re-emerge and the teacher could be relegated to the role of a mere implementer of an educational program run by others.

A final point concerns intermediation. With major platforms and the development of smartphones, distributing a product or an education resource no longer requires an intermediary. All you have to do is get access to a download link and you can then directly use the application you are looking for.

This may lead to an open market, with educational offers supported by marketing discourses, invoking the use of artificial intelligence and neuroscience, minimising the mediation provided by teachers. It is not clear what will happen, but it is important that research takes hold of these issues.

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Annex: Pointing to the moon' is noted in the work Liuzutanjing

English translation based on a translation from Chinese into French by LI, Lin Xia

Wujinjangni was talking to liuzu Huineng: I have been studying "niepanjing" for many years, but there are still many points I don't understand, and I would like you to explain them to me.

Huineng replied: I am illiterate (I can't read), could you read it to me, then I might be able to help you.

Wujinjangni said with a smile: you can't read, how can you explain this classical work?

Huineng replied: There is no relation between truth and writing, truth is like the moon in the sky, writing is the finger that goes up to the moon, the finger can go up where the moon is, but it is not the moon itself, (moreover), to look at the moon, it is not obligatory to go through the finger that goes up to the moon, isn't it?

Therefore, Wujinjangji read "niepanjing" to Huineng, Huineng explained to him sentence by sentence, there is no point that doesn't correspond to the original meaning of this work.