Digital tablets: a Trojan virus for IT in education?

Jean Simon

Digital tablets: a Trojan virus for IT in education?

Jean SIMON, Université de La Réunion

The Asian Conference on Technology in the Classroom
Official Conference Proceedings 2015

Abstract

IT, still now, has not really entered classrooms because its use constitutes a work overload for teachers. It requires several breaks that teachers must manage: breaks in time, in space and in pedagogy. Digital tablets avoid all those breaks; this is why they should be soon omnipresent in classrooms. Therefore, we have to try, right now, to see how this will change the educational landscape and how the roles of students and teachers should evolve.

Keywords: digital tablets

iafor
The International Academic Forum
www.iafor.org

Introduction

There is no translation in English for the French word "informatique". "Informatique" is the automatic processing of digital information. So, for the following, we will use "Information technology" (IT) as translation of "informatique". For M. Serres (2013), information technology revolution is equal to the one of writing. Writing has allowed storing information on a medium other than brain and, thus, the outsourcing of memory. Computers allow to process information by a medium other than brain and, thus, the outsourcing of many other cognitive processes. This outsourcing is already showing its effects. For example, calculator has made that fewer and fewer people are able to do mental arithmetic. This outsourcing of cognitive processes has led some researchers to consider otherwise their research objects. One of the main ideas is that we should not consider the "person-solo" but the "person-plus" (Perkins, 1993): the person "plus" his environment (books, computers, other people ....).

This paper is a prospective paper which relies on the existing literature on IT for education. It shows that digital tablets should not follow the cycle of a new technology described by Cuban (2001) which ends with the underutilization of this new technology. On the contrary, digital tablets should be widespread and really used in most of the classrooms. This will enable information technology to enter those classrooms and to modify them with the emergence of what we could call students "plus" and teachers "plus". First we explain why digital tablets should be widespread. Second, we present what changes should appear in classroom due to that. Finally we discuss some possible points of failure.

I. Tablets are the Trojan that will allow information technology to finally get into the classrooms

A. Failure of IT represented by the traditional PC

1. Failure

In all countries, findings are the same. We observe many local successes of introducing IT in education. However, large scale, there are everywhere an integration slowness and much greater difficulties than expected (Fourgous, 2012; Cuban, 2001). One of the reasons often invoked to explain this is that the use of IT in classroom implies to change pedagogy (Fourgous, 2012). However, Cuban (2001) doesn't go in this direction: having observed the diffusion of IT, he finds that it is not because the students studied with computers that pedagogy is necessarily modified. He said the majority of teachers use technology for reproducing or for supplementing traditional activities rather than to innovate. This finding was echoed several times (Blin & Munro, 2008; Eynon, 2008).

So we can wonder if the necessity of a change in the way of teaching could be the major reason for the underutilization of IT. Maybe it should be better to tackle the problem in terms of cost-benefit. This is what do Abboud-Blanchard & Robert (2013): If the benefit that teacher gets by a change exceeds the cost, it is likely that he will opt

for change. The problem is that this benefit is not proven. Thus Cuban (2001) has demonstrated that studies showing that use of IT should facilitate learning are often counterbalanced by studies showing that its use has no impact.
Nevertheless, if we cannot be sure of the benefit, we can be sure of the cost: most studies show that the use of IT represents a heavy workload, particularly for the preparation of the class. Fourgous (2012) noted "Achieving all or part of a course with IT requires time that everyone is not willing to invest." For Gentil (2000), and Cleary et al (2008) the reasons given by teachers to explain their non-use of IT are the overwork in the course preparation and in the rooms and material management.

2. Reasons for the work overload

Going in the same direction, Karsenti and Gauthier (2006) indicate that, if IT is underutilized, this is because it doesn't correspond to the class organization. One of the predominant aspects is that machines, most of the time, are not in the classroom but in a computers room. That involves several breaks:
- break in time: time required or expected to access the computer room, (Cleary &al, 2008)
- break in space: to leave the classroom and go to the computers room, (Cleary & al, 2008) (Gentil, 2000)
- break in equipment : material failure, often due to its use by different users, (Gentil, 2000)
- and possibly break in pedagogy: a minimum, frontal instruction disappears. Students will focus on the machine and this will give "over the shoulder" pedagogy and not face to face.
A classroom lives, and often the constraints due to PCs are in contradiction with this life (Bétrancourt, 2007). In the computers room, student activities are often disconnected from the life of the class.

B. Tablet avoids all these breaks

Thus, we believe that, if, till now, computers have not entered classrooms, one of the main reasons is that there was not enough space (in the strict sense) into classrooms for them. It's not possible to put one PC per student in classical classrooms. With notebooks there is always the power supply problem. Digital tablets eliminate those two problems. They can be assimilated to books, classical schoolbooks.
Boujol (2014) has enumerated the properties that make digital tablet similar to a book:

- Like a book, tablet can be easily integrated in classroom:
  - it can fit in the locker, or in the student briefcase
  - its screen is not interposed between student and teacher,
  - the absence of mouse, replaced by touch screen, and the lack of power cable, due to autonomy, enable a small footprint. Thus, space on table is sufficient.
- Like a book, tablet provides immediate access, you can leave tablet on standby all day without problem.
- Like a book, tablet is mobile.
- Like a book, tablet allows easy classroom management, in "one to one" or workshop.

Finally, tablet seems easier to use than a computer for non-technophiles. Kinship with smartphones is probably the reason.

This similarity to the book should make that tablets will be easily integrated in class. The investigation of Karsenti and Fievez (2014) shows it. Their study examined 6057 students and 302 teachers who were equipped with tablets. 88.5% of students reported using them an average of 30 minutes or more for a 60 minute class period.

C. Tablet is going to be a Trojan horse for IT in education

Thus, tablets should not follow the Cuban's cycle (Cuban, 2001) because they do not require extra work, they do not require a change in pedagogy. Moreover their cost can be very low (Melhuish & Falloon, 2010). Those are the reasons why they should be widespread.
The question which arises is what types of uses will occur. This is here that we have to consider that a digital tablet is a computer able to process information. This will make tablet a Trojan which will introduce information technology in classrooms.
The results should be:

- Tablet will start to take over the education of students,
- Roles of teachers and students will change,
- A lot of information on what happens in the classroom will be digitized.

II. What will be the impact of this Trojan?

So, with the tablets, the automatic processing of digital information will get into classrooms. This will necessarily have an impact on all information generated there, but also on people who emit and receive this information. This will profoundly change the various roles of those people but also the reasons why they are together in classroom.

A. Student-plus

Nowadays, we have no more to educate a student, we have to educate a student "plus", "plus" digital tablets, "plus" Internet. A child, who has grown accustomed from an early age to seek answers to his questions on Internet, doesn't think in the same way than his elders. Similarly, a child, who knows that he will find again his answers on the Internet, will not memorize them in the same way. So we can consider that the skills he will have to acquire will not be the same than those of his parents.

1. The example of the calculator

To explore those possible changes, we can consider the example of the calculator. A calculator is also a computer that can process information. Since its first appearance, its ability to process information has led to changes in the teaching of mathematics.

For some researchers, calculator hinders the development of mental calculation and memorization of the tables (Schaub, 2009; Bourdenet, 2007). Bourdenet (2007) found that, nowadays, college students are less familiar with mental arithmetic than 10 years ago. The reason is that calculators are everywhere outside of the school and basic mental calculation is no longer maintained in everyday life. The problem is that good mental arithmetic skills are needed to control higher-level process: to be able to provide an order of magnitude, to be critical towards a result...

The example of the calculator leads us to split skills that students must acquire, or not, in three categories:
- Skills not to be acquired anymore (for example, to be able to extract a square root);
- New skills to be acquired due to the use of this computer tool (e.g. to be able to program his calculator);
- Skills to be strengthened in school because their practice outside of school will tend to weaken (e.g. to be able to do mental arithmetic).
In addition to these skills, we could propose a metacognitive skill: enabling students to know when they have to use or not their calculator.
These proposals can be generalized to any computer and more particularly to digital tablets. In what follows we give some examples.

2. *Skills that we accept to abandon*

Skills, whose learning is no longer needed, can be twofold: On the one hand, skills that we accept to outsource on the machines, on the other hand, skills that have become obsolete.
If there is some agreement on the fact that the algorithm of the square root extraction should no longer be taught, because it can be outsourcing on the calculator, it is not the same for the abandonment of the learning of the division algorithm (Charnay, 2002).
Similarly, the abandonment of the learning of cursive writing is debatable. This abandonment is a good example of abandonment for obsolescence. Proponents of abandonment argue that in our digital society this skill is no longer necessary. Opponents argue that this skill is the basis of other higher-level skills such as learning to read, communication or fine motor skills (Blazer, 2010).

3. *Skills to be strengthened*

Skills to be strengthened are the counterpart of skills which can be abandoned. It is difficult to identify them a priori because: First, we must anticipate those that a continued use of machines will make the individual to lose and, second, we must assess how this loss will be detrimental to him. The loss of mental calculation mentioned above is a good example of this kind of skill.
For example, with the advent of the Internet, Graham and Metaxas (2003) have demonstrated the need to strengthen critical thinking about the information found on the Web. Liu (2005) for his part shows that reading on the Internet is characterized by more time spent browsing, non-linear reading, selective reading so he proposes to strengthen the linear reading of long books.
To our knowledge, there is no research on the impact of the use of the GPS to move around. We can wonder to what extent it will affect the sense of direction or the ability to read a map. If, indeed, the GPS has an impact on those skills, do we have to strengthen their learning in school or do we accept their outsourcing on machines?

4. *New skills to be acquired*

The new skills needed in the digital era, are probably those that are currently the most studied (Eshet, 2004) (Bawden, 2008). They constitute the digital literacy (Eschet 2004). According to Eshet (2004), they can be spread in different categories: cognitive, motor, sociological or emotional. They can consist in skills such as to be

able to build new information from existing information on the web, or build collaboratively information and share it.
Among these new learnings, programming a computer is under debate (Temperman & al, 2014). Thus, the Royal Society in Britain or the Academy of Sciences in France call for the development of this learning in elementary school. The major reason is that a future citizen should be able to dominate the IT main concepts in order to fulfill his role in a society where computers are omnipresent. The detractors consider this learning is not a fundamental learning and also it will confuse other basic skills because of the time it will require (Temperman & al, 2014).

5. *A metacognitive skill*

Maybe the more important skill that students should acquire is a metacognitive skill: *to be able to know when they have to use IT and when it's better not to use it*.

B. Teacher « plus »

We saw above that teachers are not all prepared to change their way of doing class and that one possible reason is the cost of this change. Digital tablets do not require changing pedagogy, there is a possible use of them for each teacher profile. That's why we believe they will become widespread.

1. *Different types of possible uses of the tablet by the teacher*

There are different pedagogical approaches for IT in education (Benoit & Sagot, 2008):

- The "tutorial" approach where computers can be considered as "a kind of coach." It is based on systematic exercises, assessment and remediation programs, etc.
- The "prosthetic" approach where computers and specialized input / output devices become tools that can directly or indirectly compensate a loss function in disabled child.
- The "augmentative" approach where computers and writing tools (or calculation, or consultation) allow increasing the student's skills.
- The "re-education" approach, where computers are intended to address some difficulties that a student could meet.
- The "procedural" approach, where computers become powerful inducers of reasoning and creativity (see LOGO and especially the micro-world of the turtle)
- The "communicational" approach, where networks and Internet allow establishing distance exchanges.

Villemonteix and Khaneboubi (2013) find that teachers who are project promoters have more complex use of tablets based on an important educational thought and on an asserted technicality that allow them to combine those different approaches. For (Melhuish & Falloon, 2010) most innovative uses are based on connectivity and convergence, (approach "communicational"). For Bétrancourt (2007), these more innovative uses, which involve building knowledge by students, collaboration and exchange of ideas, are seen as inaccessible by many teachers. Thus, the other teachers, depending on the discipline, use the tablet for either training or assessment activities

(tutorial or rehabilitative approach) or for consultation online resources, etc. (manual and augmentative approach). Anyway, if, according to their profile, teachers use tablet differently, the survey of Karsenty and Fievez (2014) shows that all of them use it. They show also that, when tablets are used heavily, it is essentially as digital schoolbook.

2. *Digital schoolbook*

Digital schoolbook should generate a kind of paradox. It should be widespread because teachers can use it without breaking with their usual practices and, at the end, it should lead teachers to change their practices.

a) From paper schoolbook to interactive digital schoolbook.

The digital schoolbook can range from simple digital PDF version of the paper textbook, to interactive textbook through enriched textbook. When textbook becomes digital, it is possible to enrich it with video, animations, augmented reality, etc. (Park & al, 2012). Just adding these media already allows a first adaptation to different profiles of students: more visual or more auditory etc. (Bedi, 2014). Moreover, these enriched textbooks can become interactive (Tuesdays & Everhart, 2013) with the addition of a whole set of features: moving the pages, zoom on images, text highlighting, annotations, synonyms, cross references. Some of those features are more focused on learning: file transmissions, assessments, creation of learning content (Park & al, 2012). Gradually, these digital schoolbooks reinvent the schoolbook itself and become learning methods or training resources management systems. This makes that student is gradually taken over by the machine. This provides more easily differentiated instruction in classroom where individualized and tailored applications are adapted to each student (Melhuish & Falloon, 2010). The choice of applications can be done by the teacher given the needs of his students but, more and more, can be operated by the machine given the assessments it has automatically done. Therefore these digital schoolbooks become, gradually, intelligent tutoring systems where domain knowledge and student are modeled (Huang & al, 2012). These systems take into account the errors of the student and offer him situations that allow him to correct them (Li and Akahori, 2013) (Bang & al, 2013).

b) Modifications in role of the teachers

This type of schoolbook will necessarily change the role of the teacher in the classroom. A part of his work will be shifting on the machine. Take the example of the learning of handwriting in kindergarten (Jolly and Gentaz, 2013): When children learn to write, teacher can show a limited number of times how to draw letters. Moreover, he cannot be behind each of them to verify that the pupil follows approximately the right track. Both aspects, to show and to verify, are supported now by tablet and can be repeated endlessly by the pupil. Thus, progressively, teacher should be relieved of a whole set of tasks: correction of exercises, proposal of remedial exercises, etc. This will change what he was doing before. He should become a facilitator who guides the student (Noor-Ul-Amin, 2013 ; Park & al, 2012). However, it is important to note that this transformation will not appear abruptly: it will be progressive.

C. Digitizing information produced in classrooms

In today's society, most of information is digitized on machines (photos, music, telephone conversations, medical files, bank files, etc). These data are thus easily accessible and studied. So far, in education, those studies concern rather distance learning. In online education, the use of groupware, learning management system or distance education grows increasingly. On these systems, students deposit documents, participate in forums, share with their teachers and with their colleagues. Most of these systems record the traces of these activities. These traces constitute huge masses of data that researchers are studying. Their approach includes use of algorithms: decision trees, rules induction, artificial neural networks, Bayesian learning,... (Romero & Ventura, 2007) that reveal rules, behaviors which can be classified or clustered. In the context of education we speak of Education Data Mining (EDM). The goal of EDM is to improve the teaching process by providing feedbacks at all levels both at the institution level that defines the teaching programs, or the teacher's level following a set of students remotely.

Until now, this type of research could not enter classrooms because it was very rarely that information, appearing there, was digitized. The arrival of digital tablets will change this in depth because they will lead to digitize a larger share of information generated in a classroom. This information can be studied to improve learning (Huang & al, 2012). Suppose, an interactive schoolbook used by several thousand students. Its editor will be able to observe the exercises where students are successful, those on which they fail. Better yet, if there is failure, he can check the type of errors that appear most of the time and try to remedy them by offering other types of exercise, other approaches. The schoolbook is, thus, increasingly customized to the student profile (Huang & al, 2012).

We see how the arrival of these tablets could advance educational research. We also see that this would lead to a virtuous circle: data study -> improved schoolbook -> improved learning-> data study ->...

III. Discussion

The above does not address the problems that are emerging in the use of digital tablets. A partial list of these problems could be:

- Bandwidth problems,
- Maintenance problems and software management problems,
- Non-school use problems,
- Problems because tablets would be only consultation tools,
- Teachers training problems.

These problems should not be ignored because they can generate work overload for teacher and block the widespread use of tablets.

The bandwidth problem often appears in the articles (Karsenti & Fievez, 2014 ; Boujol, 2014). We have seen that tablets allow communicating between peers or with teacher. There can be also exchanges with servers, for example, when digital schoolbooks are online. So there could be an accessibility problem. In school, the network may not function properly especially for overload reasons when all students are connected at the same time. Outside the school, student might not have access to a network (Karsenti & Fievez, 2014). Indeed, if the bandwidth is reduced, or there is no,

this limits the uses but this does not prohibit them totally: Digital schoolbooks can be on tablets and there can be local communication solutions between machines.

The problem of tablets management is a recurring problem in papers (Villemontaix, Hamon) (Boujol, 2014). This management consists in the recharge of tablets and the loading of applications. These two problems are not identical while loading of applications is done only from time to time, recharge of tablets shall be done several times per week. This problem raises the underlying question of who owns the tablet and therefore who manages it. If it belongs to the student, it is to him that it will be asked to put in charge every night and to install the applications. If the tablet belongs to the institution it will be necessary to have good mobile device management system to not generating any work overload for teachers.

Another problem cited (Karsenti and Fievez, 2014) is the use of tablets for non-school purposes (social networks, games). This one is pretty easy to get around by setting up internet filtering. Also it seems to disappear with education, students disciplining themselves progressively.

Another problem reported is that tablets can be used only for consultation and not for production. Karsenti & Fievez (2014) and Villemonteix & al (2014) wonder if, in fact, the deficit for a production use is not related to a misunderstanding of the tool.

According to many researchers (Boujol,2014; Karsenti & Fievez,2014) if tablets are spreading, it seems that the only self-study of the teachers will not be sufficient and it will be necessary to train them. We wonder if it will be still true in a few years when everybody will use them permanently.

There is a last point which is important to discuss but which will not impede the widespread of the digital tablets. We can wonder if each data which is digitized is not a loss of freedom. If this question is important for the society, it is necessarily important for schools at the time we begin to digitize information in the classrooms.

Conclusion

We proposed that information technology is not entered so far in classrooms because there was physically not enough space for it in classrooms. Therefore, to use IT, teachers have to go out of their classrooms; this generates a whole series of work overloads. By its functional proximity with the book, tablets remove all these obstacles. That's why they should be widespread in all classrooms.
However, in contrast to the book which only store information, tablet is able to process information. This will change considerably all relations in the classroom, between student and teacher, between student and other students and between student and knowledge. This, thus, leads to look at skills that a student, who constantly has access to this tool, must acquire: those that can be abandoned, those that must be strengthened and finally the new ones that must be acquired. This also leads to reflect on the triangle "student-teacher-knowledge" and the new position of the teacher in this triangle.
In the discussion, we mention the possible obstacles to this dissemination of the tablets.

Bibliographie

Abboud-Blanchard, M., & Robert, A. (2013). Strategies for Training Mathematics Teachers. In *Mathematics Classrooms* (pp. 229-245). SensePublishers.

Bang, J., Kang, S., & Lee, G. G. (2013). An automatic feedback system for English speaking integrating pronunciation and prosody assessments. In *Speech and Language Technology in Education*.

Bawden, D. (2008). Origins and concepts of digital literacy. *Digital literacies: Concepts, policies and practices*, 17-32.

Bedi, K. (2014, May). Tablet PC & smartphone uses in education (Tablet Tours). In *37th International Convention on Information and Communication Technology, Electronics and Microelectronics* (MIPRO) (pp. 940-945).

Benoit, H., & Sagot, J. (2008). L'apport des aides techniques à la scolarisation des élèves handicapés. *La nouvelle revue de l'adaptation et de la scolarisation, 43*, 19-26.

Bétrancourt, M. (2007). Pour des usages des TIC au service de l'apprentissage. in Gérard Puimatto (ed.) *TICE : L'usage en travaux, N° hors-série des Dossiers de l'ingénierie éducative* (pp. 127-137).

Blazer, C. (2010). Should Cursive Handwriting Still Be Taught in Schools? Information Capsule. Volume 0916. *Research Services, Miami-Dade County Public Schools*.

Blin, F. & Munro, M. 2008. Why hasn't technology disrupted academics' teaching practices? Understanding resistance to change through the lens of activity theory. *Computers and Education, 50*: 475-490.

Boujol, L. (2014). *Usage pédagogique des tablettes tactiles numériques : une étude de cas en enseignement primaire genevois.* [Travail de master]. Genève : Université de Genève, TECFA/MALTT, Faculté de Psychologie et des Sciences de l'Éducation.

Bourdenet, G., (2007). Calcul mental, *Activités mathématiques et scientifiques*, Irem de Sttasbourg , *61*, 5-32.

Charnay, R. (2002) Pour une culture mathématique dès l'école primaire. *Bulletin de l'APMEP n°441*.

Cleary, C., Akkari, A., & Corti, D. (2008). L'intégration des TIC dans l'enseignement secondaire. *Formation et pratiques d'enseignement en questions*, *7*, 29-49.

Cuban, L. 2001. *Oversold and underused: computers in the classroom*. Cambridge, MA: Harvard University Press.

Eshet, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*, *13*(1), 93-106.

Eynon, R. 2008. The use of the World Wide Web in learning and teaching in higher education: Reality and rhetoric. *Innovations in Education and Teaching International, 45*: 15-23

Fourgous, J. M. (2012). Apprendre autrement à l'ère numérique. *Rapport de mission parlementaire.*

Gentil, C.. Les novices en informatique, attentes en formation, utilisation des TICE et evolution. Revue de l'EPI (Enseignement Public et Informatique), 2000, pp.101-108.

Graham, L., & Metaxas, P. T. (2003). Of course it's true; I saw it on the Internet!: critical thinking in the Internet era. *Communications of the ACM*, *46*(5), 70-75.

Jolly C., Gentaz E. (2013) Interfaces tactiles et apprentissage de l'écriture manuscrite, *Sticef*, vol.20, 2013,

Huang, Y. M., Liang, T. H., Su, Y. N., & Chen, N. S. (2012). Empowering personalized learning with an interactive e-book learning system for elementary school students. *Educational Technology Research and Development*, *60*(4), 703-722.

Karsenti, T., & Fievez, A. (2014). l'iPad à l'école: usages, avantages et défis. In *Conférence prononcées au «Sommet de l'iPad en éducation», Montréal, CRIFPE*.

Karsenti, T., & Gauthier, C. (2006). Les TIC bouleversent-elles réellement le travail des enseignants. *Formation et profession*, *12*(3), 2-4.

Li, K., & Akahori, K. (2013). Development and evaluation of a feedback support system with audio and playback strokes. *CALICO Journal*, *26*(1), 91-107.

Liu, Z. (2005). Reading behavior in the digital environment: Changes in reading behavior over the past ten years. *Journal of documentation*, *61*(6), 700-712.

Melhuish, K. & Falloon, G. (2010). Looking to the future: M - learning with the iPad. Computers in New Zealand Schools: Learning, Leading, Technology , 22 (3)

Noor-Ul-Amin, S. (2013). An effective use of IT for education and learning by drawing on worldwide knowledge, research, and experience: IT as a change agent for education. *Scholarly Journal of Education*, *2*(4), 38-45.

Park, C. S., Kim, M., & Yoo, K. H. (2012). Design and implementation of a problem-based digital textbook. *International Journal of Software Engineering and Its Applications*, *6*(4), 213-222.

Perkins, D. N. (1993). Person-plus: A distributed view of thinking and learning. *Distributed cognitions: Psychological and educational considerations*, 88-110.

Romero C., Ventura S., (2007), "Educational Data Mining: a Survey from 1995 to 2005". *Expert Systems with Applications*. Elsevier 1:33 135-146, 2007

Schaub, B. Utilisation de la calculatrice dans l'enseignement des mathématiques du primaire. *Bulletin de la Société des Enseignants Neuchâtelois de Sciences*, n° 38, Juillet 2009, Sciences de l'éducation

Serres M. https://www.youtube.com/watch?v=-o1Nrz2w_Y8

Temperman, G., Anthoons, C., De Lièvre, B., & De Stercke, J. (2014). Tâches de programmation avec Scratch à l'école primaire: Observation et analyse du développement des compétences en mathématique. *Frantice. net*, (9),

Tuesdays, M., & Everhart, N. (2013). From Paper to Pixel: The Promise and Challenges of Digital Textbooks for K-12 Schools. In *Educational media and technology yearbook* (pp. 93-118). Springer New York.

Villemonteix, F., & Khaneboubi, M. (2013). Étude exploratoire sur l'utilisation d'iPads en milieu scolaire: entre séduction ergonomique et nécessités pédagogiques. *Sticef*, vol.20, 2013,

Villemonteix F., Hamon D., Nogry S., Séjourné A., Hubert A., (2014) Expérience tablettes tactiles à l'école primaire - ExTaTE. 2014. <hal-01026077v2>