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A systemic model for differentiating school technology integration

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School technology integration rarely begins with school or educator choice. It is part of a wider context where external and internal factors have direct influence on the goals and tools that are adopted over time. The objective of this study is to investigate the systemic conditions that contribute or inhibit the development of different activities by teachers making use of new media. We compiled a list of well-known conditions for technology integration success and mapped these in the historical and culturally bound perspective of activity theory (cultural historical activity theory). We conducted a multiple case study analysis of four schools, public and private. The results point to unique and distinctive scenarios even when homogeneity would be expected, reinforcing the argument that material conditions do not determine pedagogical outcomes nor do they determine changes in practice. Beyond this, the study proposes a methodology that can help elicit tensions in technology integration, pointing to avenues for school development.

Keywords: school; new media; technology; systemic

Introduction

Valuable projects have aimed to integrate educational technology in schools around the globe, in the name of innovation and change. There is always hope that these designs and interventions will flourish and positively influence school activities and practices. Many projects do not attempt to modify and effectively challenge the grammar and operation of schooling, beyond what is needed for the temporary implementation of the project (Tyack and Tobin 1994). There is no doubt that sustaining successful interventions is a challenge, but one which researchers cannot ignore if they aim to do more than add to the long list of 'what works', ephemerally. Fishman and colleagues have appropriately incorporated some of these ideas into *systemic design-based research*:

> We understand that not all researchers who work with technology will find work in systemic reform contexts appealing or appropriate ... But the field, as a whole, would benefit from engaging in systemic design-based research on technology innovations ... If we do not make progress in this area, we will have missed an opportunity to bring some of the most potentially valuable technological innovations from the research community to bear on the ongoing challenge of systemic school reform. (Fishman *et al*. 2004, p. 70)

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Though we are generally interested in what happens during interventions, there seems to be less interest in what happens on the day-to-day operations of schooling (cf. Cuban 2001).

It has become a truism to assert that artefacts are neither neutral tools nor do they determine in social activities. Still, their influence in social settings is being recognised as an essential component in the development of human activity, in varying degrees. Within educational contexts, we know different artefacts can contribute but do not determine pedagogical orientation (Salomon 2002). In other words, an activity might be extremely successful without the use of novel artefacts. It is also quite difficult to judge the quality of the activity simply by the novelty of gadgetry or pedagogical perspective. It can be argued that teachers are, generally speaking, not deterministic about their practice. Teachers facilitate numerous types of activities that are more or less innovative, and make more or less use of novel artefacts without the support or interventions of external actors.

As an example of these influences, one could cite educational policy. Because educational technology deployment in school programmes generally follows the top–down approach of educational policy in general, artefacts reach schools charged with a substantial amount of predetermined guidelines for use, training, support and other pertinent elements of the system. Looking at educational technology interventions through a wider lens from the beginning allows us to make sounder decisions in identifying configurations of media and methods that can address political, economic, ethical and equity constraints.

Beyond the common condemnation of the public school as antiquated and the teacher as defiant in their use of technology, there is a need to better understand how context impacts, restrains and inclines on new media use in educational activities. School teachers, in Brazil and abroad, are increasingly making use of media to prepare and mediate educational experiences (CETIC.br 2015).

In this study, we follow an increasing body of research aimed at a more complex and systemic understanding of the web of relations that influence on teachers' use of educational technology. We make use of cultural historical activity theory (CHAT) to identify tensions in technology integration within school systems. This methodology was applied in a cross-case study based on four cases with both private and public schools in Brazil.

Systems, ecologies and activities

Lim (2002) proposes that 'many [. . .] studies lack detailed investigation of what actually takes place in the Information and Communication Technology (ICT) learning environment and its sociocultural context. ICT does not exist in isolation; it is interwoven with the rest of the tools and participants in the learning environment' (p. 411). A systemic investigation is a methodological necessity, even for those whose aim is to create generalisations: '[w]ithout observations of the whole system of interrelated events, hypotheses to be tested could easily pertain to the educationally least significant and pertinent aspects, a not too infrequent occurrence' (Salomon 1991, p. 17).

Nardi and O'day (1999) propose looking at these settings as information ecologies, 'a system of people, practices, values, and technologies in a particular local environment. In information ecologies, the spotlight is not on technology, but on human activities that are served by technology' (p. 49). Zhao and Frank (2003)

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investigated the differential use of computers in 19 schools by examining schools as ecosystems, computer uses as living systems and teachers as keystone species. The ecological perspective is also systemic: 'An ecological systems thinker proceeds with an eye to the relationships between any given system and its superordinate, coordinate, and subordinate systems, for those relationships strongly influence the success of any change effort' (Squire and Reigeluth 2000, p. 145). The investigation of technology integration through a 'systems' lens demands a framework that will consider multiple levels, entities and their relationships over time.

Within this framework, there is increasing interest in theories that go beyond institutions and people in order to incorporate objects and non-humans as essential components (or participants) in how humans and collectives make sense, organise and develop. These frameworks include actor-network theory, organisational semiotics and activity theory (Hornung and Baranauskas 2013). Within the realm of education, activity theory has become a powerful theoretical perspective to study goal-directed activities. In CHAT, multiple actors engage towards an *object* and produce a shared, historically determined outcome that is mediated by tools. The original concept of activity theory stems from the work of Vygotsky on tool mediation (particularly language) and has been extended to include both psychological and cultural (including physical) tools (Engeström 1987).

Methodology

We began the investigation by gathering a number of studies that discuss factors which hamper or facilitate the integration of educational technology in schools (Cuban, Kirkpatrick, and Peck 2001; Groff and Mouza 2008; Hew and Brush 2007; ISTE 2009; Lowther *et al*. 2008; Pelgrum 2001; Sorj and Lissovsky 2011; Zhao *et al*. 2002). We avoided adding 'new factors to the ''laundry list'' of factors associated with technology uses' (Zhao and Frank 2003, p. 801). Directly or indirectly (through mediation) these factors impact the use and adoption of new media by teachers in the classroom (Table 1). We suggest that different systems might produce different conditions, which in turn lead to different sorts of activities in schools. To researchers and practitioners in the field, most of these factors will be quite familiar. What we do not generally do is treat them in a systemic fashion (Park *et al*. 2013).

These factors were aligned with the systemic model proposed by Engeström (1987, Figure 1), which is based on CHAT. With this, a tentative working model of the relations between an activity system and a school was created (examples will be provided in the results section). The activity diagrams permit a clear visualisation between different elements of the school activity system and the tensions (evidenced by factors) that might develop through the integration of technology. We see the

Table 1. Factor list.

Access to tools	Peer relations and support
Assessment alignment	Professional learning
Community support	Technical/pedagogical support
Culture – school	Student competencies
Culture – subject	Teacher competencies
Curriculum connection	Time constraints
Leadership	Tools and infrastructure
Educational regulation/legislation	Vision and plan
Financial sustainability	

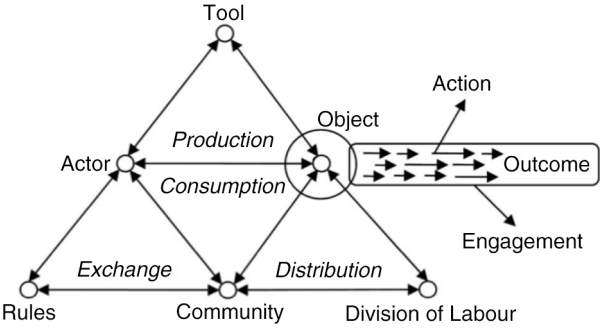

Figure 1. Activity diagram (Amory 2014).

factors as reducing or amplifying contradictions or tensions within the system. They might also contribute to expanding or reducing the margin of manoeuvre teachers have in regard to their use of new media.

CHAT has been used to investigate different educational contexts, from higher education (Amory 2014) to basic education, the object of our study. Lim (2002) expanded the activity diagram to include a series of concentric circles which involve the course of study (e.g. assessment), the school (e.g. type), the educational system (e.g. policies) and society at large (e.g. employers). These factors and actors clearly impact school and teacher activities and can lead to a substantial misalignment between what more distant participants envision and what actually takes place in schools (Karasavvidis 2009). Lim and Hang (2003) demonstrate the use of CHAT during a case study using interviews with key actors to identify contradictions that emerge between different levels of the school system. A similar methodology was used by Demiraslan and Usluel (2008), who investigated ICT integration in two schools using the perspective of teachers as a starting point in identifying relations and contradictions in different school activity systems.

One application of CHAT is to look at how tensions emerge as individuals (such as school administrators and teachers) work in a specific context (a school or a classroom) permeated by regulations, division of labour, tools and other factors (Paula and Moreira 2014). The analysis of contradictions and tensions is particularly useful in studies involving educational technology given the (usually purposeful) disturbances these projects have in organisations, such as schools. The analysis of the tensions that emerge in educational technology projects from the perspective of teachers can help understand how changes in educational practice might take place in school contexts (Murphy and Rodriguez-Manzanares 2008).

In this study, we considered the *object* of analysis as technology integration, in broad terms. The analysis of the object is meant to understand a purpose or a latent

Table 2. School interviews conducted.

	School years	Teachers	Principals	Coordinators
Private A	1–12	4	1	1
Private B	1–12	3	1	1
Public C	1–5	2	1	0
Public D	6–9	2	1	1
Total	–	11	4	3

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quality to a collective activity: '[t]he OBJECT is a heterogeneous and internally contradictory, yet enduring, constantly reproduced purpose of a collective activity system that motivates and defines the horizon of possible goals and actions' (Engeström 2004). We believe that technology integration has been an enduring collective object and an underlying focus of collective action in schools (Cuban 1986). Through the guise of pedagogical innovation, digital inclusion or economic gains, most school personnel have a latent understanding that it is a collective expectation.

Tools were defined narrowly, focused on the hardware and systems made use by teachers for educational purposes, excluding more managerial uses of software. We were interested in investigating technology as *new media*, or computational media (for details, see Manovich 2001), which in schools amounts to tablets, digital white boards, computers and the systems that run on, or support them (here, we use 'new media' and 'technology' interchangeably). *Actors* were defined as teachers and school administrators who were interviewed and observed in this study. *Rules* were focused on legislation and regulation that is defined by or forced upon the school (state, administration, etc.). The *division of labour* can help identify how relevant actors distribute responsibilities within school (such as technical support). *Community* is identified with all relevant actors mentioned by participants, usually including parents, co-workers, volunteers and the like.

We made use of a case study method, taking the school as a case. We created interview and observation protocols deriving questions from our factor list, as they pertained to the relations in the activity diagram. These included protocols for (1) school principal interviews, (2) pedagogical coordinator interviews, (3) teacher interviews, (4) classroom observations and (5) post-observations debriefing interview with teachers (Table 2).

Interviews with principals were done to understand current school context and practices, and a short (5 years) history related to educational technology projects. Interviews with pedagogical coordinators were aimed at understanding how the perspective of administrators is passed on to teachers and how concerns and problems reported by teachers are dealt with by administration. Teacher interviews focused on personal trajectories and practices, factors related to their day-to-day involvement with making use of educational technology in teaching, collaborative practices, their knowledge of project and policies and equipment access and use.

Teachers were selected based on recommendations by school principals. All protocols were semi-structured with follow-up questions, allowing for detours and deviations. The interviews were transcribed and (1) analysed to create a diagram for each actor, (2) joining the most common and prevalent elements into a single diagram for the school. This process was done in multiple iterations, until agreement between the three researchers was reached. The diagrams do not include every element presented by individual actors. We aim for this to be a diagnostic tool that would also allow us to typify and compare activity systems, highlighting essential tensions.

Four schools from the city of Brasilia participated in this study. Two private schools were chosen because of their open publicity on the use of educational technology. Two public schools were chosen, selected from a list of six provided by the State Education Secretariat. The selection criteria were not opened to us, but we assume that (1) the units were selected from the outskirts of the city, and (2) the schools demonstrated experiences with educational technology that were considered particularly interesting by the Secretariat.

Identifying differences in activity systems

Brazil is a federative republic in which states and municipalities share responsibility with the federal government. The Federal District, where Brasilia is located, shares the responsibility of both state and municipality. For public schools, we can identify two strong spheres of influence: the Ministry of Education (MEC) and the Government of the Federal District (GDF) that directly impact schools. MEC influences schools through a myriad of programmes that have historically promoted ICTs through the purchase of equipment, content and teacher professional development (IPEA 2015).

For private schools, the influence of the federal and state government can be felt on regulations regarding curricula. Both schools are part of larger conglomerates. One is part of a collective local like-minded schools, which in turn, as a group, adhered to the teaching methodology and philosophy of a larger nationwide conglomerate. This might entail actions like adopting a particular perspective on curricula, purchasing of educational materials, management systems, evaluation tools and the like. The second school is part of a large, nationwide private conglomerate, responding directly to a central office, sharing in the brand, values, curriculum and methodologies of the larger organisation.

Below we present each school individually with their corresponding diagrams and details concerning the most relevant tensions and contradictions.

Private school A

We interviewed the principal, a coordinator and four teachers, and observed two classrooms. The instructors that we interviewed teach high school subjects. Private school A is a traditional and large institution in Brasília, which includes kindergarten, elementary and high school students of high socio-economic status (SES). It is a unit of a larger educational group. It offers paid activities – including educational robotics – as well as a computer lab, projectors in the classrooms and interactive white boards. The central unit of the educational group to which the school belongs maintains a portal with information and activities for students and teachers (Figure 2).

The school offers a week for pedagogical training for teachers, but it does not focus on the use of technologies in classrooms. This may explain why some teachers have difficulties using these technologies. Moreover, there is no formal pedagogical support for the use of technologies. Some teachers reported asking for assistance from colleagues in case of necessity (*tension actors-tools*).

The school offers robotics as an activity apart from the main curriculum. As it is optional, there is no formal student evaluation (*tension rules-object*). School management does not seem so sure about the success of initiatives that involve the implementation of the use of new media. There is no explicit policy to encourage the experimentation by the teachers (*tension actors-community*).

The school curriculum is defined, in part, by the central educational group, which is located in another state. General planning is created and pushed by headquarters, and teachers must plan lessons and adapt activities to fall within this framework. Some teachers mentioned that part of the content needed adaptation to be used locally. Moreover, there are only two paid hours per week to prepare classes. These factors might contribute to the low level of flexibility in class planning and to a low level of experimentation – regardless of the use of specific technologies – by the teachers (*tension rules-actors*).

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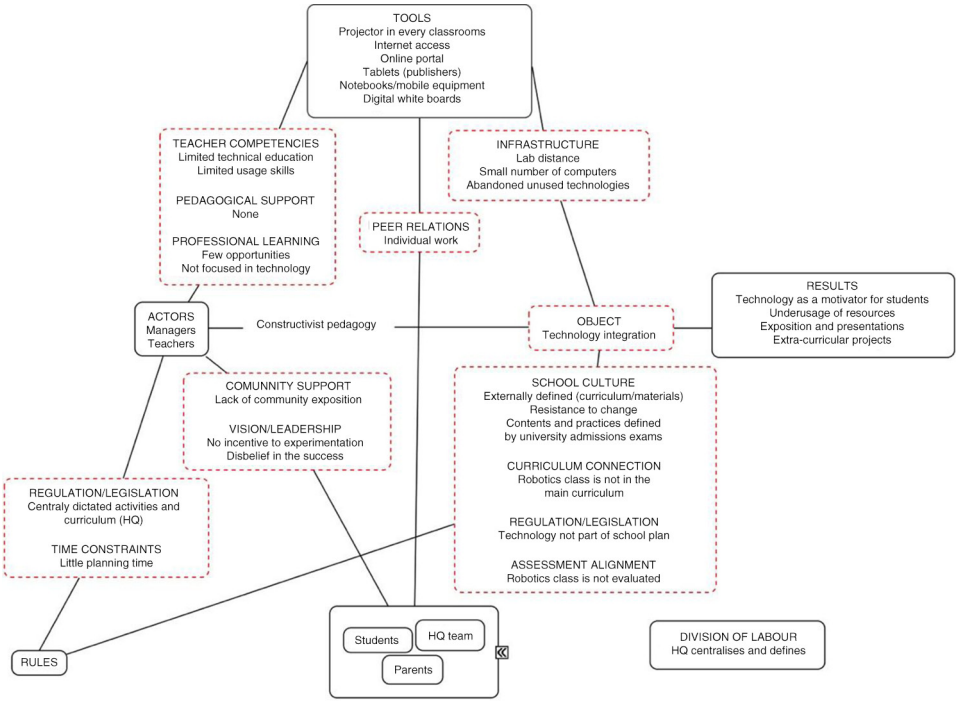

Figure 2. School A diagram.

According to those interviewed, the main motivation for the use of technologies in the school seems to be to attract students' attention, and not within a larger consideration of its integration as a pedagogical tool. As a result, the resources available are used especially in extracurricular activities and as an audiovisual tool (*tension intrinsic to the object*).

Private school B

We interviewed the principal, a coordinator and three teachers, and made two classroom observations. The instructors that we interviewed teach in the elementary school. Private school B is also a large institution, catering to high SES students. It is also a unit of a larger educational group, from which it uses school contents but with local autonomy. In comparison with private school A, private school B has a greater variety of programmes integrated to the curriculum and greater drive for pedagogical experimentation, using technology in manners that are both constructive and informational. Technical training is offered to help teachers in making use of technologies in classrooms. The school also invests in the training of the management team.

The use of technologies in school B is characterised by the existence of coherent projects, determined cooperatively by the principals, coordinators and teachers. Managers and some teachers of private school B have undergraduate or graduate degrees in areas related to educational technology.

There is a recent trend to integrate technologies inside the classroom, which are all equipped with projectors and interactive white boards. There are also four

differentiated learning environments built to cater to the needs of specific knowledge areas (such as humanities). The school offers digital and board games that students use in a specific room and that are also meant to be used at home with the parents. The robotics programme is part of the compulsory curriculum. The school offers technological and pedagogical support for the activities that use technologies.

Similarly to school A, school B pays only 2 hours per week for class preparation, which might inhibit experimentation in the classroom by the teachers (Figure 3).

There is a gradual transition in the use of technologies in the school. The computer lab – a model considered outdated – is giving place to the use of tools in the classroom and in the differentiated learning environments, which leads to a shift in how school personnel, particularly the laboratory teacher, perceive themselves (*tensions tools-division of labour*). Students and parents have high expectations concerning the infrastructure and tools at school, having their personal electronics as a reference point. This might lead, in turn, to frustration with outdated computer lab equipment. The school constantly seeks updates and novelties to satisfy the expectations of students and parents, as well as to promote its pedagogical orientation, but teacher competencies and training do not always follow pace (*tension actors-tools*).

Even though there is a conscious integration between the activities involving technologies and the demands of the curriculum based on competencies, only part of the teachers use the technological resources provided by the school. For example, the interactive white board is frequently used as equipment for projection of images, not as an interactive tool. There is indication that some teachers are resistant to experimentation (*tension actors-tools*).

Curricular demands both by the government and by the headquarters have a great impact in the activities developed at the school. High school creates its own demands,

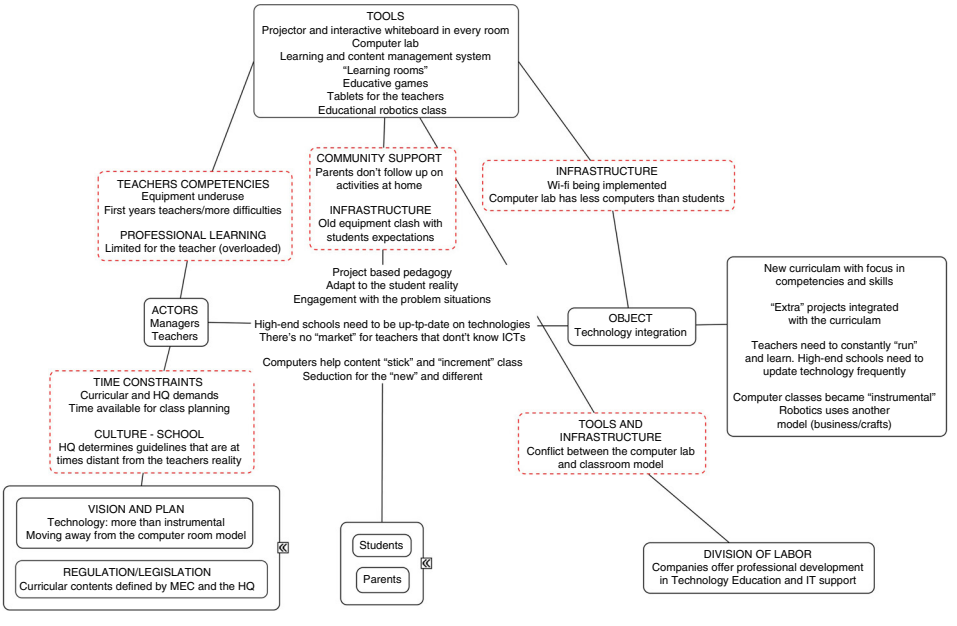

Figure 3. School B diagram.

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with a focus on entry to university. This in turn reduces activities that are more constructive and/or make creative use of technologies. As an example, more advanced classes underuse the computer lab – as its use was, but no longer is, compulsory (*tension actors-rules*).

The school offers activities that require the involvement of the parents, especially educational games to be played at home. Some parents show resistance to this practice, failing to understand the pedagogical potential or simply because they don't have time to participate (*tension community-tools*).

Public school C

We interviewed the principal and two elementary school teachers. The school does not have a pedagogical coordinator. Public school C is a small rural elementary school. It attends primarily the children of local workers. About a third of the students take part in the full-time education programme. Unlike the other three schools, this school does not offer a robotics programme. Even though it is a rural school, it has a good technological infrastructure, with a computer lab and classrooms equipped with projectors and computers.

The individual initiative of the principal is the main explanation for the quality of the infrastructure. By means of partnerships, she/he managed to gather multiple resources and services for the maintenance and enlargement of the school. It is also evident that she/he played a key role in building a motivated team prizing the quality of the education in the institution. Classes make intense use of the available technological resources. Still, Internet access is limited and unstable, and classroom activities do not benefit from it (Figure 4).

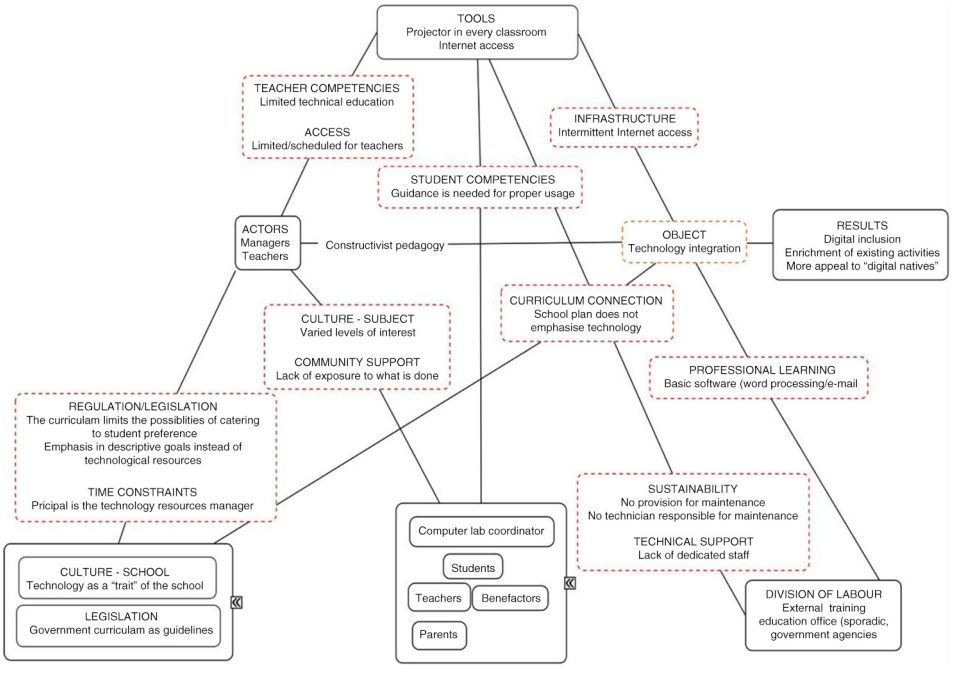

Figure 4. School C diagram.

The school's pedagogical programme does not comprehensively contemplate the use of technology in education. Uses are defined on a case-by-case basis, without an overarching plan that connects them with a greater educational goal (*tension rules-object*). The interviewed educators point to legislation – characterised by curricular goals – which also do not deal with the integrated use of technologies in educational activities. Goals are defined based on content to be covered.

There is a school culture that incentivises the use of technologies, which leads to the expectation of its use by educators. The teacher does not need to schedule the computer lab in order to use the equipment, as there are projectors and computers in each classroom. On the contrary, the computer is used only in combination with the projector, and there is little student engagement. In case of technical problems, equipment was available for immediate replacement.

Many teachers do not have sufficient technical training to use the available tools, which limits the creative possibilities for the use of new media (*tension actors-tools*). Educators suggested that the interest in the use of new media differs markedly from teacher to teacher. The interest of the teacher does not necessarily have a direct correspondence to his or her technical competence, which is aggravated by the lack of specialised technical support.

Activities involving computers and projectors usually depend largely on the access to the Internet. The schools Internet link is insufficient for the use of audio or video with students, which again limits possible activities and contributes to an underuse of the resources (*tension tools-object*).

The principal usually calls on the community for help in tasks like the building of furniture. On the one hand, this is positive, as it denotes community engagement. On the other hand, it points to the limited sustainability of the technology plan. There is neither a maintenance contract for the equipment nor available technical staff. This leads to instability in the activities that depend on technology. There is also no technical support for the activities themselves, a function that is answered for by the principal (*tension division of labour-tools*).

Finally, the *object* showed some contradictions. Even though school actors say it follows a constructivist approach, the object of the technological integration seems more devoted to motivate students in the school activities, to attract 'digital natives'. Student motivation was a fundamental drive for the use of new technologies.

Public school D

We interviewed the principal, a coordinator and two teachers, and made two classroom observations. The instructors that we interviewed teach in the elementary school. Public school D is a midsize institution, with students from middle and low SES. About 10% of the students take part in the full-time education programme. The school has a programme for gifted youngsters, which serves students from public and private schools in the region.

The school does not have computers, projectors or interactive white boards in the classrooms. It has rooms for projections and a computer lab, which need to be scheduled in advance by the teachers. The school has a robotics programme that was initially available only for the gifted students programme, but that is being opened to include all students from the full-time education programme.

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The school has a radio project, which includes web radios, and equipment used to edit sound and for transmission. A volunteer initially developed this initiative and the students and parents provide the necessary resources (Figure 5).

The principal does not have a personal interest in the use of technologies. However, she/he supports the activities that are developed by the school coordinator. There is no evidence of a culture of use of technologies by the teachers (*tensions actors-tools*).

Legislation and central planning create serious limits on how the school deals with equipment, both novel and old, and what it can purchase with available financial resources. There are difficulties in equipment maintenance: much of what is available is not used and cannot be legally discarded. The result is that the school has to keep piles of old equipment. When the school receives new computer equipment, there are operational difficulties in rejecting those that are dead on arrival (*tension and rules-actors*). Moreover, there are no technical support personnel (*tension division of labour-tools*). Some equipment is bought with resources donated by the parents or local companies. Part of the students does not have access to equipment at home, which may affect their instrumental competence with the tools available at the school (*tension tools-community*).

Teachers have to teach an excessive number of classes, which makes it difficult to experiment and implement innovative or creative practices (*tension actor-rules*). The lack of resources contributes to limit the scope of activities that make use of the technologies in the school. The limited-bandwidth Internet access provided by the government is not sufficient for activities involving student participation. In order to remedy this, the school collects community funds to pay for a faster Internet connection.

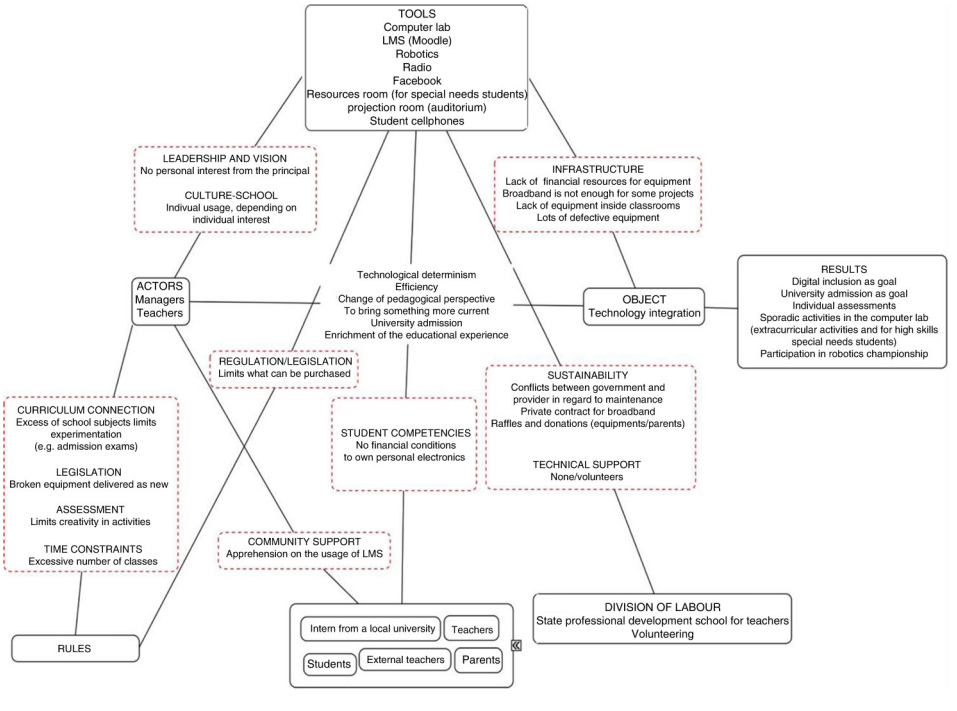

Figure 5. School D diagram.

Classrooms do not have projectors or computers, and when teachers need these, they have to schedule a specific room in advance. The students have to physically move there, which is recognised as a substantial waste of instructional time (*tension tools-object*).

Despite the above-mentioned tensions, school practices point to the possibility of digital inclusion for many students, as well as the increase in the participation by teachers in projects involving new media. Some evidence for this can be found in the positive results achieved by school students in external robotics competitions. Projects involving new media focused on the gifted students attract the attention of the other students. The school plans to include a great number of the students in these projects as it expands the full-time curriculum. There is, for now, integration between the gifted students and full-time education programmes, as some of the gifted students participate in activities along with the full-time students.

Analysis

The data presented here suggest that the use of new media is strongly influenced by planning and administrative leadership. This in turn generates an environment more favourable to experimentation and use by teachers. When these conditions are not present, the pressure is on an individual actor, usually a teacher, who becomes an isolated agent – an exception to the rule. Public schools demonstrate a more creative vein in the use of their limited resources. Interesting and novel activities were identified, such as radio programme in one school and teaching about agriculture involving ICTs in another. The individual initiative determines the existence and survival of these programmes. There is greater teacher autonomy in public schools and also more frail sustainability. These actions are not part of a larger school culture and do not find systemic support. Consequently, they might vanish if its champion disappears or momentary support dissipates.

The distance between a distant headquarters and the school for day-to-day schooling can create an asymmetry in expectations. Reduced time for planning a centralised curriculum and other determinations can make it hard for administrators and teachers to experiment. On the contrary, a well-defined structure can contribute to more cohesive action, one that envisions not only equipment but also a clear alignment between curriculum, practices, architecture and devices, as evidenced in one of the schools. These external actors provide a team that can examine curricula and legal demands, promote opportunities for professional development and mediate external agents (e.g. providers), which in turn can lead to a more sustained and cohesive transition. This might never occur were schools left to their own devices (and resources).

In public schools, educators have to worry about routine material questions, such as maintenance and acquisition of equipment. In public schools, there is a clear effort by administration in the constant search for alternative ways to build a better school and technology infrastructure. This may generate interesting learning opportunities despite the lack of resources.

Though the private schools were similar in terms of student SES, prestige, location and espoused teaching philosophy, the analysis portrays markedly different roles for new media. This helps negate pedagogical determinism of technology richness. In one school, there is a preoccupation with the relationship between technology and curriculum, administration, access to resources and so on, as part of a process of

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change for the school as an organisation. The other school displays a more tenuous integration of technology. We identified tensions in both, but in very different terms.

Some comparisons across the public/private divide are possible. When comparing private school B with public school C, we found similarities in the way new media are integrated in their pedagogical proposals. School B focuses on projects and school C has a constructivist approach, perspectives which are usually associated with each other. In both schools, new media are integrated into subject areas and are used as a complement to classroom activities. On the contrary, private school A and public school D use technology primarily in extracurricular activities, apart from the regular subject areas. There are similarities between private school B and public school C, where equipment available in the classrooms is replacing the use of computer labs and technology outside the classrooms.

In all four cases, classes follow a traditional teacher–student relationship, except in the case of robotics classes. Robotics is a separate course and follows its own grammar. The robotics courses, which show a more participatory and active engagement by the students, are outliers in terms of method, content, mentors and goals. Classes follow an entrepreneurial model, part of a methodology that is sold to schools as a package that goes beyond the hardware itself; this moves the experience closer to a *shop* or *maker* movement. The goals, for at least one school, are also external: participating successfully in one of many competitive robotics championships promoted outside of school. We identified cases where robotics activities are integrated with curricular objectives. Unless these types of synergies can expand to promote structural change, it is doubtful that they will contribute to any meaningful change to other activities.

As pressures from external examinations and community expectations for college entry increase, high school has also become, more than a level of schooling, a 'school within a school'. Here, the integration of technology is likely to be limited by the pressures of time and excessive content, and is not necessarily a function of the availability of resources or competence.

Regarding schools that have a high school level, systemic pressures to cover extensive content (or competencies), more so in private, but also in public schools, are evident and pervasive. In this context, any initiative that aims to increase experimentation, greater engagement and depth – where new media could be of interesting use – tend to be neglected. This represents a tension between the purported objectives of the school and the overarching rules, materialised in the form of college entrance exams.

Conclusion

In this study, we propose a CHAT-based methodology for the systemic investigation of tensions and contradictions with a focus on technology integration in schools. While we recognise that to typify is to reduce, we believe there is value in modelling patterns of tensions. This study supports the idea that educational actors see the integration of technology in schools as a vector for 'modernisation', aiming to increase motivation and engagement of students. But external pressures and contingencies manifest themselves in pre-defined margins of manoeuvre and unique expectations by different actors (Sun 2006). Therefore, there is often a conflict between the purported objectives and the actual results.

We did not identify a relationship between a robust infrastructure and pedagogical orientation. In spite of decades of discussions on the limited power of infrastructure and artefacts in directing change to school culture and teacher practices, we find

ourselves once again obligated to emphasise this point. We have evidenced that tools make themselves present and available in very different terms and constitute a significant part of how schools envision change in practice. Brazil, like many other countries, continues to promote a failed model of technology integration propelled and focused on the large purchase of devices as agents of change (Cornils 2011).

Some caveats are called for. It is not trivial to get private, prestigious schools to open their doors to scrutiny. Teachers who were initially interviewed at the end of one semester were no longer part of the school when we returned to observe their classes. For public schools, the GDF's school recommendations might have promoted a biased view on technology integration. In either case, observations were done on the suggestion of the principal, which points us in the direction of teachers and activities with exemplary or heavy ICT usage. Still, particularly in earlier years (1–5, 6–9), ICTs seem to be a tool for teachers' use or extracurricular activity. If a bias did exist, our observations point to a more traditional and teacher-centred approach to integration. There is no evidence of administrator or teacher hesitance in presenting the dilemmas and tensions in their practice.

This study was not aimed at evaluating the quality of teaching or school administration. Our focus was exclusively directed at the *object* of this study. The results of the study will be presented to each school in hope that contradictions and tensions may lead to reflection. We hope that these insights and methods can help schools build more systemic and realistic strategies for technology integration, whatever their goal or scope may be.

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