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Facilitating change in primary education: The role of existing school facilities in ICT initiatives

1. Introduction

Rapid developments in digital technologies over the past two decades have generated a period of significant social and cultural change. In the developed world digital technologies impact on almost every aspect of society and increasingly these technologies, and the opportunities that come with them, are being taken for granted. But the benefits are not enjoyed by all. Inequality in the use and application of digital technologies has become a driver of exclusion, which risks accelerating existing social divides as well as creating new ones (Warschauer, 2003; Selwyn, 2004; Finquelievich, 2006). In simple terms, digital exclusion is a symptom of wider exclusion within and between countries, but it is also a cause. As a direct consequence, the last decade has seen an array of ICT initiatives in education aiming at decreasing inequality and digital exclusion (cf. Warschauer *et al.*, 2004; Gulati, 2008). These initiatives commonly share the same fundamental aims of improving the quality of education through the introduction of ICT tools (laptops); and promoting digital literacy amongst pupils (Nugroho and Lonsdale, 2010). A prime example is the One Laptop Per Child (OLPC) project, which provides children in developing countries with Internet connected laptops. In Uruguay, 'Plan Ceibal' is a deliberate attempt to promote digital inclusion in the educational system. The initiative is aimed at both decreasing the digital divide and improving the quality of the education that is delivered in schools across the country. Through the initiative, which is a part of the national educational plan, Internet-connected laptops are distributed to all public primary school children and teachers at no charge for the pupils' families or the schools (Balaguer, 2010).

The impact of ICT in schools goes beyond the purely pedagogical and has the potential to affect many other aspects of school life; from altering present teaching practices and providing the opportunity for teacher development to improvements in the quality of the learning environment. This paper takes as its point of departure that such changes are more likely if they are compliant with the context into which they are introduced. As such, it explores the relationship between the articulation of the educational vision, the introduction of ICT and the accomplishment of compatible learning environments. Particular attention is given to how the physical environment can support or impede the introduction of laptops and associated pedagogical ideas in forming effective learning environments. Thus, the aim is to illuminate and bring into context how increased access to, and appropriation of, a certain form of ICT tool (individual laptops) affect existing pedagogical practices; and to unravel some of the many implications that this will have for the design, operation and maintenance of existing and future school facilities. To start, Plan Ceibal is briefly introduced. Attention is then turned to the broader literature on ICT in education and how the introduction of new technologies is increasingly considered to play a role in changing pedagogical practices and generating novel approaches to learning. The third part of the paper highlights and discusses the link between the

introduction of the new technology and the way that educational facilities are used. The discussion focuses on how the roll out of Plan Ceibal puts existing equipment and facilities to the test. It is argued that the initiative brings with it significant potential for change in teaching and learning processes, but that this will lead to new requirements for the school facilities. The paper concludes with reflections on the impact that the implementation of the Plan Ceibal imposes on the existing school infrastructure. In particular, a case is made for the need for further research into whether the effectiveness, and ultimate benefits of the initiative, is limited due to insufficient attention being given to the operational context into which the new technology is introduced.

2. Plan Ceibal

Despite relatively high attendance rates amongst pupils and that the social and income distribution indicators were amongst the highest in Latin America, Uruguay was in 2007 one of the countries in the region with the highest level of inequality in learning (OECD, 2007). 'Conectividad Educativa de Informática Básica para el Aprendizaje en Línea' [Basic Educational Connectivity for Online Learning], or 'Plan Ceibal' as it has become known, was developed to address this inequality. The initiative was launched by the Uruguayan government in April 2007, with the intention of providing, free of charge, one portable computer to each pupil and teacher in public primary education. At this time, 43% of public primary schools in Uruguay had no computer equipment available to pupils, 43% had between one and four computers and only 14% had five or more (Grupo Radar, 2010). This reflected the situation in society in general where approximately 30% of Uruguayan households had a computer and only half of these had Internet access (Vazquez, 2009). In 2010, full coverage of public primary education was achieved with 350,000 laptops (commonly referred to as XOs) delivered (CITS, 2010). The decision was subsequently taken to extend the initiative to secondary public schools (*ibid*). As of February 2013, 566,522 XOs have been distributed to pupils and teachers in public primary and secondary schools in the country (Plan Ceibal, 2013). This equates to approximately 20% of the population being in possession of a personal XO.

The specific objectives set for Plan Ceibal by the Uruguayan Education Commission (Comisión de Educación, 2007) focus on the provision and use of the technology. However, it is clearly recognised that the mere introduction of the laptops in schools is not enough to ensure the aspired to changes. Hence, emphasis is also given to the need for appropriate training programmes for those involved together with a push for the introduction of teaching and learning approaches that is in line with the new requirements. Accordingly, the distribution of laptops has over time increasingly been complemented with the provision of additional resources and training. The incorporation of the XOs into the day-to-day practices in schools has, according to the initiative's own records, had a degree of success. Some commentators point towards evidence of changes in peer communication amongst the pupils going beyond the use of the technology (Balaguer, 2010). Changes in the pedagogical relationship between teachers and pupils have also been encountered, where pupils have been found to help teachers with the use of the new technology (Pérez Gomar and Ravela, 2012). However, to date there is only sporadic non-systematic evidence of the positive impact of Plan Ceibal and its effects on

enrolment, attendance, motivation and graduation rates (cf. Rivoir and Lamschtein, 2012). This is perhaps not all that surprising given that experiences from elsewhere show that several conflicts arise when new technologies are introduced into the educational system and there are a host of considerations that need to be made (cf. Hinostroza *et al.,* 2004). Not least amongst these is how the introduction of new technologies and changes in pedagogical approaches conflict with existing school facilities and infrastructure.

3. ICT in education

Academic studies in the field of ICT in education are by no means a new phenomenon. The past ten years have seen a vast array of research in this field (e.g. Angrist and Lavy, 2002; Warschauer, 2008; Tolani-Brown *et al.*, 2009; Pena-Lopez, 2010; Malapile and Keengwe, in press). Not surprisingly, the findings from these studies vary immensely (cf. Condie *et al.*, 2007). Some commentators claim that new technologies have the potential to fundamentally transform how and what people learn. This part of the literature is replete with claims about the revolutionary potential of ICT to impact on enhanced student learning and increased quality of education (*ibid.*). Others are more sceptical and note that, although many positive results have been reported on a small scale, there are considerably fewer improvements in attainment that can be linked directly to the introduction of ICT on a large and replicable scale (e.g. Hepp *et al.*, 2004; Balanskat *et al.*, 2006). Hence, it seems evident, from the large literature on the topic, that new digital technologies have the potential to revolutionise education (cf. Anderson, 2010), yet it is equally clear that they certainly do not guarantee it. To the contrary, experience shows that change initiatives imposed on the schools, teachers in particular, all too often are used to reinforce existing approaches to learning rather than bringing about change (Woolner *et al.*, 2012). It follows, therefore, that to take full advantage of new ICTs there is a need to rethink traditional approaches to teaching and, perhaps more importantly, to understand what constitutes an effective learning environment.

The necessary precursory transformations for such a change to happen are arguably already taking place. A gradual change in emphasis has been clearly discernible in the educational literature for quite some time now. The traditional discipline based agenda for teaching and learning is gradually giving way to one based on creativity, innovation, critical reflection, teamwork and the collective construction of knowledge (e.g. Gardner and Hatch, 1989; Woods and Jeffrey, 1996). This emerging agenda is built around concepts such as dialogue, ownership, innovation, flexibility, equality, democracy, individuality and freedom. Some commentators take these concepts one step further and go as far as to argue that the availability of ICT means that education is just as effectively delivered outside of schools, which in turn renders school buildings unnecessary (cf. Hepp *et al.*, 2004). Such a position might seem radical, but it becomes much more viable if the school is conceptualised as an organisational unit rather than a physical entity. However, not surprisingly, this disconnection between the physical environment and the teaching and learning approach has been heavily criticised (e.g. Jamieson *et al.*, 2000; McGregor, 2004). Rather than abandoning the school building it is argued that the somewhat abstract concepts mentioned above can be translated into concrete objectives for the school, and be embedded in the physical design of the learning environment. This line of reasoning finds

support in a plethora of studies that have shown that changes in pedagogical approaches accompanied with the use of the appropriate technology can be successfully supported by altering the way in which spaces and buildings are used (cf. Leiringer and Cardellino, 2011).

4. Facilities and educational attainment

In the educational research literature, it is commonly argued that the physical environment plays an important role in shaping student behaviour (e.g. Day and Midbjer, 2007; Durán-Narucki, 2008; Gislason, 2010; Barrett *et al.*, 2013). How the school building is designed and maintained is understood to play a central role in the creation of environments that improve educational attainment. A wide variety of studies have focused on the tangible physical aspects of design and its functionality; proclaiming correlations between the physical school environment and improved levels of teaching and learning. A near consensus seems to exist that basic physical variables (e.g. natural ventilation, colour, temperature and acoustics) have an effect on learning (cf. Woolner, 2010). Indeed, clear links are drawn in the literature between the improvement of poor learning environments and increased pupil motivation and attainment (Higgins *et al*, 2005).

It should be further noted that school buildings provide for a variety of social groups within their premises. Spaces govern and support interactions between these groups. Ultimately, spatial design and how the facilities are maintained and used, both, facilitate and inhibit behaviour and relationships between different actors (cf. Penn *et al.*, 1999; Heerwagen *et al.*, 2004). The social interaction within these spaces is commonly put forward as a critical factor in establishing the relative success of the learning environments (Tanner, 2000). Hence, aspects of the physical environment, such as classroom and school size (cf. Darmody and Smyth, 2012), and the degree of openness of the spaces (e.g. Bennett and Hyland, 1979; Horne-Martin, 2004), have an impact on educational outcomes. Wireless ICT, as provided by the laptops in Plan Ceibal, have an impact on the physical environment as it has the potential to challenge existing notions of space and place. In theory, its introduction could make physical distances less of an issue and enable the creation of personalised spaces that are ‘moveable’. In summary, the importance of the link between education and the design, condition and use of learning spaces should not be underestimated (e.g. Woolner, 2010; Zhang and Barrett, 2010; Adeyeye *et al.*, 2013).

5. Research Design

The paper draws on a multiple case study set up to investigate the role of the school facilities and their immediate surroundings in mediating the successful introduction and adoption of individual laptops (XOs) in primary education in Uruguay. The case study consists of five public primary schools chosen through purposive sampling. Two of the schools were completed after the announcement of the Plan Ceibal and are located in deprived areas of the capital Montevideo characterised by high unemployment rates and very low family incomes. These two schools host 200 and 312 pupils respectively. The three other schools were, as the majority of the schools in the country, built in the 1930s and are located in areas with very different socio-economic conditions: one in a poor city neighbourhood (362 pupils), one in a middle-class area (260 pupils) and one in a rural area (77 pupils). At the time of the data collection, May-July

2011, the pupils and teachers in each school had been in possession of XOs for approximately 3 years.

A variety of data collection techniques were used. To start, guided tours were taken of the school buildings and the surrounding grounds. These were given by the head teacher. In the two new build schools the responsible architect also provided a separate tour explaining the thinking behind the design decisions. Both direct and indirect observation techniques were used. Classes were observed directly with the presence of the researchers being known to the children and teachers as well as, less intrusively, from a distance. Observations were also made of other activities undertaken in the school, and a series of informal discussions with teachers and other stakeholders, such as school inspectors and representatives from Plan Ceibal, were held. The observations followed a predefined protocol divided into 'actual use of the XOs' and 'the characteristics and role of the physical environment'. The constructs in each category were taken from the two literature sets outlined in sections 3 and 4. When deemed appropriate, photographs were taken of classrooms and in- and outdoor common areas for additional information. Separate sets of notes were taken by two researchers. These were, then, compared and compiled, and differences in interpretation were discussed at length. For each of the cases, semi-structured interviews were also conducted with the head teacher, three teachers and the designated member of staff charged with championing the implementation of the Plan Ceibal. The interviews served the dual purpose of collecting data on past, current and planned future use of the XOs and individual perceptions of the role and usefulness of the technology in the provision of education; as well as allowing for clarifications to be made regarding the observations made in each school. Added to this, the research team was also provided with 3 different types of XOs to enable a better understanding of the particularities of the technology.

6. Rethinking the use and operation of school facilities

The provision and maintenance of an adequate physical learning environment is very much an educational issue. For example, deficiencies in physical considerations, such as inappropriate furnishing, inadequate ventilation and poor lighting may distract groups of pupils from their primary learning task and thereby diminish the quality of the learning environment (cf. Zandvliet and Straker, 2001). The five schools in the sample show that there are multitude ways in which the physical environment can support, or impede, the forming of effective learning environments when introducing laptops and associated pedagogical ideas into teaching. Some of these impediments come across as fairly trivial, for example how the use of the XO is limited by the access to electricity. On average, there were no more than two electricity sockets per classroom in the schools studied. This, in combination with the limited battery life of the XOs, effectively limits the use of the XOs to two hours per day as the capacity in the school facilities to allow for the batteries to be charged is insufficient. Classroom activities that include the XO, therefore, have to be planned in advance and work on the basis that the pupils bring their XOs fully charged. Likewise, lighting solutions that have worked well in the past are no longer suitable. Adding curtains to avoid sun glare is easy enough, but this, amongst other things, necessitates the provision of additional lighting. It, therefore, seems evident that what

previously might have been adequate learning environments no longer can be considered to be so.

Other constraining features of the surrounding built environment are more complex. International experiences in evaluating the use of ICTs in education show that the introduction of the technology has had a positive, but moderate, impact on learning outcomes (Balanskat *et al.*, 2006; Tolani-Brown *et al.*, 2009). More evident is the change they produce in the short term on pupil and teacher attitudes and expectations (Balanskat *et al.*, 2006; Condie *et al.*, 2007). A major challenge in this context is to match these expectations with necessary changes and improvements of the school environment that will support and enable teacher and pupil use of ICTs. This means successfully managing the link between the physical and the 'psychosocial' classroom environment. As previously noted, the impact of ICT is mitigated by that the beliefs and practices of teachers change far more slowly than technology does. Thus, even after receiving basic and pedagogical training in ICT, some teachers will still not make use of the technology. In our study, the introduction of the XOs provoked mixed feelings amongst teachers and staff in the five schools. Some had fully embraced the laptops, but even after having undergone the provided training sessions many teachers still felt uncomfortable with the technology, and had experienced difficulties in incorporating the XOs into the day-to-day teaching. In each of the schools there were examples of teachers who were not confident in using the XOs, and thus refused to incorporate them into their classes. More commonly, though, teachers felt constrained in how the laptops could be used to alter their teaching practices. For those who had adopted the XO in their teaching the dominant mind-set was, therefore, to consider it to be an 'instrument' to teach; a resource similar to the notepad, the whiteboard or the book. The laptop was, thus, not seen as an innovation that invariably would change teaching practices or improve the quality of education. Instead, the introduction of the new technology was portrayed as a challenge.

The social interaction within classrooms and other school spaces is commonly put forward as a critical factor in establishing the relative success of the learning environments (e.g. Tanner, 2000). Several studies have, for example, sought to establish the extent to which teachers make use of available spaces and the degree to which the physical environment dictates how they teach (e.g. Moore and Lackney, 1993), and there is relatively strong agreement on the existence of a link between the style of teaching and the classroom organisation (cf. Horne-Martin, 2004; McGregor, 2004). However, studies have also shown that the tendency simply to cope with the given environment rather than actively attempting to manage it should not be underestimated (Higgins *et al*, 2005). This was certainly the case among the teachers in the five schools in the sample. Nonetheless, the possession and use of laptops impacts on how social interaction can take place in and outside the classrooms. For example, with the introduction of laptops the teacher-pupil relationship can become more fluid. In the new schools, with relatively big classrooms, this interaction can potentially develop naturally. However, the old schools which are characterised by small classrooms and large class sizes, and in which individual work spaces and classroom layouts were designed for conventional 'teaching from the front', are not equally suited for this to happen. The scope for doing something different in order to achieve learning environments that respond to the introduction of the new tool is, thus, severely limited in these

schools. Furthermore, there are no social spaces conducive for using the XOs outside the classroom as the communal areas in these older schools are very basic with only a few benches scattered around the playground and the school halls. For the two newly built schools it is notable that Plan Ceibal did not figure in the design brief, even though these schools were designed after its introduction. Indeed, no consideration was taken in the design of the classrooms and the common areas to the possible changes in teaching and learning activities that the use of the XO can facilitate. Even though these new schools might be suited for the new technology in terms of fulfilling basic physical variables, such as adequate ventilation, temperature, light and colour; they are still not adaptable and flexible enough to support potential changes in teaching and learning that the use of ICT might inspire. Outside the classrooms of the new schools there are benches and seating possibilities allowing for the potential use of these spaces for learning. However, the acoustics in these areas is poor making it near impossible to use them for pedagogical purposes.

In summary, it follows that, unless some of the structural impediments to change outlined above are tackled, the technology will be used to support existing practices and cultural values rather than encouraging new ones. These findings are supported by a recent study of teachers´ perception of the use of the XOs in the classroom in 34 public schools in the country (Pérez Gomar and Ravela, 2012), in which it is concluded that 20% of teachers have not made any changes to their teaching practices.

7. Concluding remarks

It is generally believed that ICTs can empower teachers and pupils, thus providing potentially significant contributions to learning and educational attainment. Yet, the exact meaning of 'improve the quality of education' called for within the Plan Ceibal is not evidently clear. This is certainly the case amongst those charged with teaching and learning. They perceive the introduction of the XOs as yet another tool that helps them in the day-to-day reality of imparting education, but not as an element that will help them improve it. Nonetheless, through its wide distribution of laptops, Plan Ceibal, undoubtedly has the potential to affect substantial change in society in general, as well as in education. However, its successful diffusion is reliant on it being relevant and aligned to the individual particularities of a broad and diverse school population. The roll out of the Plan will, therefore, not be uniform, but will be subjected to localised challenges. Indeed, the introduction of the XOs will not by default change teaching practices and thus, bring about educational transformation across the country. To the contrary, the introduction of the XOs is context sensitive and it cannot be extracted from the various contexts within which it takes place. The provision of training in how to use of the laptops in the day-to-day teaching is clearly important, but a clear case can also be made for the importance of adapting not only the pedagogical approaches, but also the physical environments in which they are delivered. Such arguments are, however, effectively stifled by the huge investments made in the technology and the logistics of Plan Ceibal. In comparison, investing in the actual facilities and their operation and maintenance comes across as old fashioned and unimaginative. This, we argue, is not unique to the Uruguayan context. Indeed, we would go as far as stating that it is the case in most developing countries in which OLPC initiatives are being rolled out.

The evidence of the positive impacts of Plan Ceibal and its effects on enrolment, attendance, motivation and graduation rates are inconclusive. More importantly, however, there is no readily available research that has investigated the actual implementation process. It is worth remembering that the use of ICTs in the classroom does not diminish the role of the teacher; nor does it automatically change teaching practices. Instead, successful incorporation of ICTs in the day-to-day practice is dependent on the implementation of a variety of support and enabling mechanisms. Based on this study it is evident that the school environment has an important role to play in the diffusion of ICT initiatives, and ultimately in the achievement of effective learning environments. Yet, there is little current knowledge about what an integrated approach to operating, maintaining, improving and adapting the school buildings and infrastructure in order to create a supporting environment might look like. The research challenge, therefore, is to unravel the myriad of practices, as realised in schools, situated in complex, yet specific environments, to explore the tensions that the introduction of laptops pose and establish the different ways in which these tensions can be alleviated. The current research agenda needs to be expanded to incorporate learning environments. More empirical research is needed in order to further our understanding of how the introduction of laptops changes behaviour in classrooms and the wider school environment; how individual behaviour is shaped by existing facilities; and how the use and upkeep of the facilities can be altered to respond to changes in teaching and learning approaches. This calls for a degree of creativity in research and depends on breaking with the common sense assumptions, looking at the world through a different lens and returning to professional and political communities with new insights. This is what research at its best can and should provide.

8. References

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