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Digital media adoption in schools: Bottom-up, top-down, complementary or optional?

Dominik Petko [a, *], Nives Egger [a], Andrea Cantieni [a], Barbara Wespi [a, b]

[a] Institute for Media and Schools, Schwyz University of Teacher Education, 6410 Goldau, Switzerland
[b] Institute for Educational Evaluation, University of Zurich, 8032 Zurich, Switzerland

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ABSTRACT

Past research has suggested that innovation processes in schools are more successful when they are participatory and voluntary. To examine this notion, we categorized schools into one of four different innovation-process types, based on group interviews with school staff: complementary bottom-up and top-down development (type 1), top-down development that is not supported bottom-up (type 2), bottom-up development that is not supported top-down (type 3) and optional development with neither strong bottom-up nor top-down initiatives (type 4). Based on this typology, analysis of variance was then conducted on survey response data from 357 teachers and 1051 9th grade students from these schools. In contrast with some of our expectations, we found that teachers in schools with a complementary top-down and bottom-up strategy as well as schools with a top-down strategy only showed better ICT-resources and a more intensive use of educational technology than those in bottom-up- or optional-innovation-type schools. Additionally, teachers' ICT-use in type 1 and 2 schools is predicted to a higher degree by the number of computers in the classroom than in schools where ICT-integration is bottom-up or optional. Our findings suggest that bottom-up innovation strategies are likely to fall short without top-down support, especially when funds for technology installations are missing.

1. Introduction

Despite great efforts in recent years to promote the adoption of information and communication technology in schools and its use in classroom teaching has fallen short of expectations in a number of respects (Davies & West, 2014; Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014; Korte & Hüsing, 2006; Law, Pelgrum, & Plomp, 2008; Shewbridge, Ikeda, & Schleicher, 2006. Many teachers use ICT only rarely in their teaching, and if they use digital technologies, the expected change to a more active, explorative and student-centered "21st century learning" seldom takes place (Ertmer & Ottenbreit-Leftwich, 2013; Voogt, 2008). Research has shown that successful technology adoption does not so much rely on hardware and software but, more importantly, on teachers' skills and beliefs (Christensen & Knezek, 2008; Ertmer & Ottenbreit-Leftwich, 2010; Petko, 2012; Viherä & Nurmela, 2001; Zhao & Cziko, 2001). With regard to skills, teachers need to acquire a combination of technological, pedagogical and content knowledge (in short TPACK; Chai, Koh, & Tsai, 2013; Koehler & Mishra, 2009). At the same time, teachers must be convinced that ICT will enhance the quality of their teaching and their students' learning (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Lim & Chai, 2007). Thus, measures to promote ICT adoption must be judged according to whether they support the individual teacher's skills and readiness to make use of digital media more frequently and in a way that promotes student learning. The process of adoption of educational technology takes time and effort even for the most interested teachers, while less motivated teachers are likely to abandon the task rather sooner than later (Aldunate & Nussbaum, 2013). Technology integration needs to be scaffolded by different means such as extensive professional development (Lawless & Pellegrino, 2007) and activities on the levels of teacher teams, schools, districts and higher levels of the educational system (Eickelmann, 2011; Somekh, 2008; Webb & Cox, 2004). In this regard, case studies of particularly innovative schools that have been part of model projects are an important source of information (Blamire, 2009; Bryderup & Kowalski, 2002; Kozma, 2003; Kozma & Anderson, 2002; Pegrum, Oakley, & Faulkner, 2013; Tondeur,

* Corresponding author. Institute for Media and Schools, Schwyz University of Teacher Education, Zaystrasse 42, CH-6410 Goldau, Switzerland. Tel.: +41 (0) 41 859 05 92.
E-mail address: dominik.petko@phsz.ch (D. Petko).

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Cooper, & Newhouse, 2010). According to the research conducted to date, the adoption of digital media in schools is most promising when it is linked to clear pedagogical objectives that are formulated ideally within an overarching framework. In expanding ICT resources in schools, the focus should be on pedagogical rather than technological issues (ten Brummelhuis & Kuiper, 2008; Cuban, Kirkpatrick, & Peck, 2001; Wastiau et al., 2013). ICT should be regarded as a "lever" rather than a quasi-automatic "catalyst" for education reforms (Venezky & Davis, 2002). Furthermore, all measures used to implement ICT innovation should be planned in a coordinated way. These measures include: the expansion of technical hardware and software in conformance to needs; appropriate technical and pedagogical support; organized individual and collective professional development; a network for information exchange between teachers; support from the school administration and from additional stakeholders, including parents and political or administrative offices. In addition, the success of innovation, as established by research into school development, depends not only on comprehensive planning and implementation, but also on the way changes are managed, especially the balance between leadership and joint participation in the innovation process (Bryderup & Kowalski, 2002; Dexter, 2008; Hauge & Norenes, 2014; McCharen, Song, & Martens, 2011). A summary of the EUN's STEPS study, which examined options for adopting ICT in European primary schools, describes the challengeas follows:

> "Organising involvement and enthusiasm of teachers is key. When initiatives are too top-down and when no priorities are set […] ICT is just seen as an add-on, creating more stress and the need to work extra hours" (Van Oel, 2007, p. 29).

The importance of a participatory innovation process has been demonstrated not only in relation to the introduction of digital media, but in many other areas of school development as well (Daly, Pachler, & Pelletier, 2009; Heck & Hallinger, 2009; Richardson & Placier, 1998; Somech, 2005). Fullan (1992, 2003) argues that the successful introduction of innovations in schools depends primarily on whether the staff who are involved experience "ownership" of the innovation process and see a coherent rationale behind it. This view is not confined to school development but is also generally prevalent in the field of organizational development. Rogers (1995) describes three prototypical diffusion patterns for innovations: "optional" ("individual flexibility"), "collective" ("a balance between maximum efficiency and freedom"), "authority" ("it yields a high rate of adoption, but produces high resistance"). According to Rogers (1995), innovation that is managed in an authority-driven manner is the fastest to be implemented but there is a risk that the implementation will engender resistance or will be avoided altogether (p. 29). For this reason, innovation that is authority-driven is not always successful. However, even though the research indicates that innovation processes are more successful when they are based on a bottom-up rather than a top-down strategy, there are also strong indications that a mixture of both strategies can be successful— or, at least, that the question of bottom-up versus top-down needs to be seen in the context of other conditions related to the innovation process (Fullan, 1994; Fullan, 1991). As recent overviews point out, it not only matters *that* facilitating conditions for ICT adoption are in place, but *how* they are provided in order to foster not only adequate teacher skills and beliefs but also self-efficacy and a general change of school culture with regard to educational technology (Ertmer & Ottenbreit-Leftwich, 2010; Somekh, 2008). Research concerning successful ICT adoption in schools needs to look more closely into the question of the interplay of bottom-up and top-down processes and its impact on other core factors that are known to be essential for school ICT integration. On the institutional level, the innovation process might have an impact on the provision of ICT resources and on ICT-related professional development activities. In schools where top down processes are prevalent, these provisions will most likely be more comprehensive as financial resources might be more readily available. In schools with strong bottom-up innovation processes, the infrastructure and professional development activities might be better fitting for the needs of teachers. Most likely, as proposed by Fullan (1994), a combination of bottom-up and top-down processes will yield the best results. On the individual level, teachers' skills for teaching and learning with educational technology and their pedagogical beliefs are known to be major determinants for more frequent computer use in classroom instruction. Skills and beliefs will most likely be influenced both by formal activities initiated on the institutional level (i.e. hardware provision in combination with professional development) and by informal interactions occurring in the process (i.e. experimenting with technology, talking to colleagues). Taken together, a successful combination of factors should lead to a more frequent and more comprehensive use of ICT in teaching (Inan & Lowther, 2010; Petko, 2012). This should also be visible in students' perception of ICT resources, their self-reported frequency of use, their own assessment of their skills and motivation in matters related to digital media, and ultimately in their overall performance. As all of these aspects are likely to have numerous interdependencies and be influenced by many other factors as well, the style of the innovation can be seen as an overarching process that deserves closer inspection.

2. Questions and hypotheses

Based on the considerations above, we seek to identify differences between schools in which the innovation process for digital media is managed in different ways. As a result, we expect differences in the following areas: (a) the school's ICT resources, (b) the frequency of teachers' participation in professional development activities related to ICT (c) teachers' own assessment of their ICT skill levels, (d) teachers' positive beliefs about ICT with respect to its pedagogical benefits, (e) frequency of ICT use by teachers and students, (f) students' own assessment of their ICT skills and (g) their motivation to work with computers. Based on earlier findings, we can formulate the following groups of hypotheses:

- H1: Schools with a combined participatory "bottom-up" and "top-down" innovation process will achieve significantly better results in all seven areas listed above than schools with only either a "bottom-up" or a "top-down" strategy or schools where the use of ICT is solely presented as an option.
- H2: Schools with a participatory "bottom-up" innovation strategy without "top-down" support will achieve significantly better results in all seven areas listed above than schools with an entirely "top-down" strategy or schools where the use of ICT is presented as an option.
- H3: Schools with an authority-driven "top-down" innovation strategy will achieve significantly better results in all seven of the areas listed above than schools where the use of ICT is presented as an option.
- H4: Teachers' frequency of ICT use will be predicted by the numbers of computers available in the classroom as well as their motivation and abilities to use computers for teaching. Additionally, we expect the frequency of professional development activities to be a