Understanding Technology Integration Failures in Education: The Need for Zero-Order Barriers

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7.1 Introduction

The idea that technology would revolutionize the classroom has a century-long history. Western world classrooms have experienced successive technology waves such as radio, film, and television (Cuban 1986). The availability of personal computers in the early 1980s marked the beginning of the computer era, leading to the widespread introduction of information and communication technology (ICT) in educational systems. For the past three and a half decades, educational reformers have attempted to transform education through technology without much success. This failure is characterized by two main dimensions: extent of use and type of use.

7.2 The Problem of Low Frequency of ICT Use

Technology cannot revolutionize the classroom unless teachers use it. As the literature suggests, the rate of ICT use in the classroom is rather low. While teachers do employ ICT, they use it more for personal reasons rather than for supporting learning. More specifically, research shows that teachers use ICT for administrative purposes as well as personal preparation and support (Eteokleous 2008; Gray et al. 2010; Zhao and Frank 2003). Based on the study of technology use in 19 US schools, Zhao and Frank (2003) found that while 80% of the teachers reported daily use of computer technology, this use actually included communication with parents

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and preparation for instruction. In the latest US national survey, Gray et al. (2010) report that more than 90% of the public school teachers in their study used technology frequently for entering grades and attendance records. Productivity applications, the Internet, and administration applications are indeed the dominant types of software use in schools (Gray et al. 2010). In a study of Cypriot teachers, Eteokleous (2008) also found that teachers use computers extensively for personal use.

When it comes to technology use in the classrooms, studies show that classroom use grows at a slow rate and with unequal pace, depending on the context. Studies published since 2000 indicated that, even at the beginning of the twenty-first century, the rate of technology use in classrooms was low. In a survey of 4000 K-12 US teachers, Norris et al. (2003) reported that nearly half the teachers used technology for about 3 minutes a day. Similar low rates of use were reported by Webb and Cox (2004). The findings of more recent studies also suggest that teachers still use ICT rarely in their classroom practices (Hinostroza et al. 2011; Ward and Parr 2010; Wikan and Molster 2011). National studies also report similar patterns of relatively low ICT use, e.g., Norwegian teachers (Wikan and Molster 2011) and Chilean teachers (Hinotstroza et al. 2011). It should be noted, however, that recent international large-scale comparative studies suggest an increase in the rate of classroom use of technology (Law and Chow 2008; Fraillon et al. 2014). More specifically, Fraillon et al. (2014) concluded that three out of five teachers use computers at least once a week for teaching purposes. A US national survey shows similar findings, as 40% of the public school teachers reported that they or their students used computers often (Gray et al. 2010). Other studies also confirm an upward trend in terms of frequency of use across time (Cuban 2013).

7.3 The Problem of the Type of ICT Use

The most consistent finding of more than three decades of research is that technology has failed to transform teaching and learning practices. On the one hand, this finding is consistent in surveys examining the types of ICT use by teachers and students. More specifically, the Second Information Technology in Education Study (SITES) indicated that ICT adoption does not necessarily mean that traditional practices are abolished (Law 2008). Several national studies also provide similar evidence, e.g., in the UK (see Selwyn 2008; Yang 2012; British Educational Communications and Technology Agency (BECTA) 2008) and Ireland (McGarr 2009). In a survey of 19 US schools, student technology use, as reported by teachers, involved learning and practicing basic skills (69%), conducting research (66%), and word processing (61%) (Gray et al. 2010). Drawing on survey data from 35,000 teachers in 21 countries or educational systems, Frailon et al. (2014) conclude that teachers mainly use ICT for presenting information and reinforcing skills, while students typically use ICT for information searching and short assignment completion. The authors argue that the dominant pattern of use that emerges is the use of technology for relatively simple tasks.

On the other hand, studies that examine the rationale behind the learning environments that teachers design, suggest that, as a rule, technology is incorporated into existing practices rather than transform them. Consequently, despite technology integration, traditional practices are still dominant (Hermans et al. 2008; Law and Chow 2008; Player-Koro 2012) and even reinforced (Donnelly et al. 2011). More specifically, most teachers in the Hayes's (2007) study reported that ICT had not changed the ways in which they teach or the ways they design learning experiences for their classrooms. Van Braak et al. (2004) also concluded that only few teachers used technology as a learning device. Similarly, the majority of the teachers surveyed by Prestridge (2012) were simply adding ICT to the existing curriculum. Li (2007) found that computers were being used mostly as improved typewriters or simply for demonstration purposes. Finally, Eteokleous (2008) also reported that computers are used in classroom as "fancy chalkboards." Despite the fact technology has not transformed current teaching practices, the clear but slow evidence of progress has been acknowledged (Voogt 2008; Cuban 2013).

7.4 Conceptualizing Solutions

Why teachers neither enthusiastically embrace technology nor exploit its high-added learning value has remained a mystery. Theorizing and empirical research has led to two main conceptualizations of the problem, which we refer to as *pragmatic* and *historical*. The pragmatic conceptualization has been advanced by Ertmer and colleagues (Ertmer 1999, 2005; Snoeyink and Ertmer 2001). We refer to this conceptualization as pragmatic because it represents a tangible, rational, and layered approach to determine what gets in the way of using ICT in educational practices. The pragmatic conceptualization has been the dominant view over the last 15 years. Following Rasmussen and Ludvigsen (2009), we refer to the alternative conceptualization as historical. The historical approach has been put forward by Cuban (2001, 2013) and others (notably Tyack and Tobin 1994). This conceptualization stresses the importance of taking contextual factors into account in order to understand the problem of ICT uptake. While the historical conceptualization has a longer history, it has received less attention.

7.5 Pragmatic Conceptualization

In this section we will introduce the pragmatic conceptualization of the problem of ICT integration. The pragmatic approach conceptualized technology integration problems in terms of first- and second-order barriers (Ertmer 1999, 2005; Snoeyink and Ertmer 2001). This conceptualization has provided useful guidance with respect to integrating ICT in classrooms. Its core concept is the one of the barriers to ICT use. Factors affecting whether ICT gets used or not are distinguished into two types of barriers: first-order and second-order ones (Ertmer 1999, 2005; Snoeyink and Ertmer 2001). Typically, *first-order barriers* involve factors extrinsic

to teachers, namely, factors that are beyond their direct control. Such factors include (a) *infrastructure* (Norris et al. 2003; Eteokleous 2008; Granger et al. 2002), (b) *technical support* (Hayes 2007; Penuel et al. 2007), (c) *time for planning and experimentation* (Clouse and Alexander 1997; Snoeyink and Ertmer 2001), (d) *administration/leadership* (Perrotta 2013; Law 2008; Hayes 2007; Yee 2001), (e) *collaboration among teachers* (Sandholtz and Reilly 2004; Cuban 2013), and (f) *teacher training in ICT use in education* (Eteokleous 2008). As the literature suggests, all the aforementioned factors influence both the rate and the nature of technology integration in classrooms.

On the other hand, *second-order barriers* are intrinsic to teachers and address the willingness and competence of teachers to integrate ICT in their lessons: teachers' beliefs about the value of teaching with technology, their knowledge of ways to integrate ICT in their classroom, their general ICT competence, the instructional models they endorse, and their openness to change. Second-order barriers include

(a) *Teacher background variables* such as age and gender, academic qualifications, pedagogical ICT competence, and orientation to progressive pedagogies (Law and Chow 2008),
(b) *Teacher perceptions of the value of ICT in teaching and learning* (Ward and Parr 2010; Eteokleous 2008; Mueller et al. 2008; Van Braak et al. 2004; Baggott la Velle et al. 2004; Dexter et al. 1999),
(c) *ICT competence/feelings of efficacy with respect to ICT use* (Mueller et al. 2008; Wood et al. 2005; Prestridge 2012; Eteokleous 2008), and
(d) *Teacher beliefs about teaching and learning* (Hermans et al. 2008; Van Braak et al. 2004).

The conceptualization of barriers in terms of first- and second-order ones represents a major step forward in identifying the problem of ICT uptake and taking measures to address it. Nevertheless, we argue that the pragmatic conceptualization is characterized by three major limitations. First, the distinction between first- and second-order barriers is not always clear. Second, this conceptualization is typical of what is called individual-blame bias (Rogers 2003). Teachers are essentially victimized, as the failure to utilize the potential of technology has been attributed to them. Third, the pragmatic conceptualization accepts a simplified account of teacher agency.

Regarding the first, drawing a sharp line between internal and external factors might not be very straightforward. Snoeyink and Ertmer (2001) pointed out that some of the first-order barriers three experienced teachers reported when using ICT (e.g., inadequate preparation for using computers) may actually be masked second-order barriers. Mueller et al. (2008) concluded that specific, task-relevant, and classroom applicable experiences with technology facilitate technology adoption. The authors point out the boundary nature of such experiences, stressing that they are neither external (since they have to be reflected upon) nor internal (since they are enacted in the classroom). On the other hand, the complex relation between teacher beliefs and practices also reflects the problematic nature of association

between first- and second-order barriers. For example, Sandholtz and Reilly (2004) report that it is unclear if technology use leads teachers to shift toward constructivist practices or if constructivist beliefs lead teachers to adopt technologies. Ertmer (2005) also argues that change in beliefs follows rather than precedes change in practices. Last, the distinction between teacher-related and teacher-unrelated barriers might not be the most appropriate. For instance, Spillane (1999) observed that when faced with the same innovative mathematics curriculum, two teachers who were equally willing to conform differed markedly in terms of how much their core practices changed. To account for this differential response, Spillane (1999) proposed a unit of analysis that extends beyond the individual teacher. Overall, such findings are difficult to explain by simply resorting to first- or second-order barriers, namely, without an examination of historical, structural, and contextual factors.

Regarding the second limitation, teachers are seen as the key to resolving the problem of ICT integration. This is clearly reflected in the main assumption underlying the pragmatic approach: eventually, it is classroom teachers who get to decide whether and how to use technology (Ertmer 2005). The problem with this assumption is that it considers changing teacher conceptions to be the main leverage point for achieving a solution. However, changing teacher views might not necessarily result in a change in the corresponding teacher practices. This pragmatic conceptualization portrays teacher views as resulting from teachers' own free choice. While on the surface such a view stresses teacher agency, in reality it leads to the victimization of teachers: they are bound to be held accountable for any technology adoption failures. On a broader level, the literature on innovation diffusion also suggests that the "individual-blame bias," i.e., putting the blame on individual teachers, is rather common (Rogers 2003).

Lastly, the pragmatic conceptualization assumes a rather simplified account of teacher agency. According to the main assumption underlying the pragmatic approach, the stepwise resolution of the first-order barriers, initially, and of the second-order ones, subsequently, is self-evident. However, implementing a solution based on this assumption will not lead to success as the issue of teacher agency is complicated. For instance, drawing on Lortie and Clement's (1975) work, Hargreaves' (2010) concluded that the relation among teacher individualism, presentism, and conservatism is very elaborate because it is being mediated by teacher agency. Moreover, his review showed that similar stepwise reform efforts, aiming to diminish the conservatism of teachers' practices, are mired in unintended consequences.

To address these limitations, we will reconceptualize the pragmatic approach by drawing on concepts from two frameworks. First, we will introduce a historical conceptualization of the problem of ICT innovation and educational reform.

7.6 Historical Conceptualization

The historical framework provides an insightful way of looking at the problem of ICT uptake in education. This approach considers ICT innovation as a special case of reform. We draw on two particular sources for presenting the historical approach. The first source is the concept of the "grammar of schooling" introduced by Tyack and Tobin (1994). To account for the repeated failure of innovations to reform schools, the authors introduce the concept of the "grammar of schooling." This grammar constitutes the regularities that organize educational practices and involve structures and rules that regulate teachers and teaching such as the graded school, the self-contained classrooms which separate teachers and students, a curriculum that is divided into segments of knowledge and skills, curricular structures for specific age groups, a schedule which brings teachers and students together only for small periods of time, and departmental teaching which separates teachers of different academic subjects.

Through an insightful historical analysis of reforms, Tyack and Tobin (1994) document how the current school structure may be accounted for by two major innovations rooted in US education, in the early twentieth century, the *graded school* and the *Carnegie unit*. Inspired by the division of labor in factories, the graded school involved teachers teaching the same curricular subjects to a single grade in the same way and at the same time. Compared to pre-existing practices, this organizational measure afforded much greater efficiency. The second innovation that emerges as critical from Tyack and Tobin's (1994) historical analysis is the *Carnegie unit*. This unit was defined as a course of five weekly periods (each lasting up to 55 minutes) throughout an academic year. Initially meant to set the standards for university entrance, the unit represented a standard measurement of time and credit for each academic subject. The major consequence of this unit was that it led to the organization of departments in high schools. Eventually, the Carnegie unit became an accreditation requirement, meaning that the graduates of high schools that adopted this system could be admitted to universities without entrance examinations.

What this detailed analysis reveals is that the school, as we currently know it, is a historical product of decisions made by certain individuals and groups in the past. As the authors note, both innovations emerged in response to the pressing need for standardization. This explains why the two innovations were taken up without resistance, shaping education in its present form. On the other hand, while the educational system eagerly adopted these two innovations for standardization purposes, it proved difficult or even impossible for subsequent innovations to change it. Once the grammar of schooling had been institutionalized, it turned out to be very resistant to change.

The second source is the work of Cuban and colleagues (Cuban 1986, 2001, 2013; Cuban et al. 2001). Cuban's contribution is the historical examination of ICT-related educational reform and educational reform in general. Cuban also addressed the problem of reform failure and attempted to analyze it historically in structural terms. Cuban (2013) distinguishes between incremental and fundamental

change. He defines *incremental* (or first-order) changes as amendments to current structures. As he explains, these changes are superficial ones, functioning as add-ons to current practices without changing them. Examples of incremental changes include new academic subjects, new reading or mathematics programs, changes in class size, and extending the school year. What characterizes incremental changes is that they do not change the core of schooling. On the other hand, *fundamental* change involves changes in the very building blocks of schooling. Fundamental (or second-order) changes constitute foundational shifts to the core of schooling. Examples of fundamental shifts are funding (vouchers, charter schools), governance (site-based management, mayoral control), organization (age-graded school), curriculum (hands-on science), and instruction (teacher-centered, student-centered).

As Cuban (2013) notes, most of the innovations that are implemented end up being incremental rather than fundamental. Consequently, while incremental changes occur frequently, fundamental changes occur less often. Despite frequent attempts by administrators, policy makers, and other stakeholders to change teaching practices, schools have endured. This phenomenon is what Cuban (2013) characterized as "change without reform." According to Cuban (2013), to understand this phenomenon, one will have to take a closer look at what he calls the "black box" of classroom practice which is inaccessible to parents, administrators, policy makers, and all other stakeholders.

Cuban's account is interesting as the focus is not solely on the individual teacher; rather, it is on the institutional and other factors influencing teacher work. He underscores the main fallacy underlying reform policies that typically focus on teachers and their characteristics rather than the situations in which teachers find themselves. As he notes, teachers have no control over the cultural capital that students bring to school. Cuban provides detailed accounts of several reforms, some of which are directly related to ICT. In every reform case analyzed, failure is never attributed to individual teachers and their characteristics. Instead, Cuban (2013) illustrates how factors beyond the control of teachers eventually get to influence their practices. For example, he describes how certain reforms (e.g., technology, science curricula) failed to change practices while others (e.g., testing-driven accountability) had a profound impact on classroom practices. Cuban (2013) points out that the pressures exerted on teachers often have the opposite effect from what reformers aspire to achieve: teachers domesticate an innovation to adapt it to current practices, at times even going so far as distorting and denaturing it. As he argues, educators create "hybrid practices," assimilating reforms into current practices rather than change current practices to actualize reform.

What are the main insights that can be derived from the historical conceptualization approach? The main contributions of the two historical sources briefly introduced, the grammar of schooling and incremental-fundamental change scheme, involve an emphasis on the historical change of organizational structures. In the following section, we explore the main implications of the historical approach and turn to the literature (both general and ICT reform specific) for examples suggesting that a different unit of analysis is required.

7.7 Implications of the Historical Approach: Understanding Evolution in Context

The main assumption underlying the pragmatic conceptualization is that changing teacher views is sufficient for changing teacher practices. The historical approach calls for attention to context. However, once attention shifts from individual teachers to the broader context, the limitations of the pragmatic conceptualization become evident. In terms of reform, the importance of contexts has been stressed. For instance, Kennedy (2010) argued that we need to move beyond the focus on the individual teacher and examine the teaching situation itself: school, classroom, schedule, and resources. Trumbull (1999) also illustrated that it is essentially the material conditions of practice in which teachers operate that eventually shape what they are able to actualize reform-wise.

Turning to ICT reform, contexts have also been found to play a critical role. The role contextual factors play in terms of ICT use has been well documented in the literature (Olson 2000; Zhao et al. 2002; Liu 2011). Somekh (2007) argued that many factors should be taken into consideration when examining an ICT-based innovation. Granger et al. (2002) also stressed that, in order to understand how teachers relate to technology, a complex set of connections between individuals, technology, and the social, political, and material environments will have to be taken into account. The uptake of ICT has been influenced by a host of contextual factors such as school areas and subject matter (Ward and Parr 2010), working contexts (Hennessy et al. 2005), as well as school policies and context (Starkey 2010). Van Braak et al. (2004) found that only 21% of the class computer use variance was accounted for by the independent variables used in the study. The authors stressed the need to go beyond individual teachers and consider organizational factors such as time constraints, available resources, support, teamwork, and training. Interestingly, in a subsequent study (Hermans et al. 2008) where they explicitly addressed school-level factors, they found that 18% of the class use of computers could be accounted for by school-level variables. Finally, in a multiple case study Karasavvidis and Kollias (2014) examined technology integration with three highly qualified teachers. The main study finding was that the dominant local science education paradigm and the "grammar" of Greek schooling constrained rather than facilitated technology integration.

Given the importance of contexts for understanding technology integration, it is interesting to see the picture that emerges should we look at contexts. The evidence suggests that teachers value and prioritize different things compared to what researchers, policy makers, and educational authority leaders would expect. More specifically, Baek et al. (2008) inquired into reasons why teachers use technology. The reasons teachers gave included the following: external requests and expectations of others, increasing student attention, using the basic functions of technology, relieving physical fatigue, class preparation and management, and using enhanced technology functions. As the findings suggest, teachers' conceptualizations of technology are not aligned with the corresponding ones held by policy makers or researchers. As corroborated by several studies, this

finding has been consistent. Cox et al. (1999) surveyed 82 teachers on the reasons that influence ICT use in their classrooms. The findings show what teachers considered important: make the lessons more interesting, easier, more fun (for both them and their students), more diverse, more motivating for the students, and more enjoyable. According to the British Educational Communications and Technology Agency (2006) report, the criteria used by teachers to select software included the following: fit with curriculum and schemes of work, value for money, ease of use, suitable for all abilities, engaging for students, having a clear educational purpose, and adding value to other teaching. Liu (2011) also reports that the major motivational force behind technology use in classrooms is external forces such as principals, colleagues, and governments. Teachers feel pressure to integrate technology into their practices by principals, municipal authorities, and curriculum (Wikan and Molster 2011). In fact, the researchers found that most teachers use ICT for reasons of peripheral support to learning, such as access to learning materials, increasing student motivation, and improved presentations.

Overall, the aforementioned evidence confirms Kerr's (1991) initial observation that teachers' responses to the question "What determines technology use?" will probably startle academics and administrators alike, but they will hardly surprise any teachers. Therefore, what emerges is that teachers have a different set of priorities compared to administrators and policy makers. Understanding such priorities is essential as it shows what the teachers perceive of as important and why. What teachers perceive of as important is influenced by the pressures that they experience. These pressures define the material conditions in which teachers function, work, think, and practice. It is also these material conditions that eventually shape their views of the value of technology and of whether it fits into their practices or not.

The main contribution of the historical perspective is that it helps us represent the problem of ICT integration not as a singular one, namely, entirely dependent upon teacher views and choices, but rather as a problem that needs to be studied in context. This view neither negates nor denies teacher agency. However, it stresses the need to examine the scope of this agency, as teachers (a) have only certain degrees of freedom and (b) cannot operate independently of the contexts in which they find themselves. Consequently, as opposed to focusing only on changing teachers' views about technology, we will need to broaden our analytic focus to take contextual factors into consideration. While the historical approach succeeds in bringing contextual issues to the fore, it lacks the conceptual toolbox that may facilitate a more systemic analysis of contexts. Moreover, while contradictions are often described in the historical conceptualization (e.g., Cuban 2013), it lacks the concepts to theorize such tensions and contradictions.

In the next section, we will turn to a theoretical framework which provides us with the conceptual tools to (a) explicitly examine practices in systemic terms and (b) understand why and how tensions arise from the implementation of reform. As we will argue, the historical perspective can be greatly complimented by an activity-theoretical perspective.

7.8 Activity Theory Conceptualization

Activity theory (hereafter AT) has its roots in (a) German philosophy, particularly in the works of Marx and Engels and (b) in Soviet psychology. AT is situated in the intellectual tradition of cultural-historical psychology, developed by Vygotsky and his colleagues, Leont'ev and Luria, in the early twentieth century. Vygotsky's seminal work (Vygotsky 1960/1981, 1978, 1987; Vygotsky and Luria 1994) provided the general foundations for studying human consciousness. Vygotsky's focus was on how material and nonmaterial tools such as signs mediated human mental functioning. He examined how material and specifically nonmaterial tools such as signs and symbols mediate human mental functioning. As represented by the well-known triangle (see Fig. 7.1), a subject does not act on an object directly: material and nonmaterial tools mediate the subject's relationship to an object. Vygotsky's principal contribution was the broadening of the unit of analysis, which involved taking into consideration mediational means as well as social others. This mediational scheme represented the first generation of AT (Engeström 2014).

Leont'ev shared the same starting points with Vygotsky. However, unlike Vygotsky, who focused mostly on symbols and signs, Leont'ev's approach to consciousness was a more materialist one. In his approach, activity is used as the main explanatory principle (Leont'ev 1978, 1981a, b). Leont'ev's conception of the activity involved the distinction of activity, action, and operation which correspond to motive, goal, and conditions, respectively. An activity is always object-oriented in the sense that it tries to meet a specific need which represents the motive behind the activity. Depending on the complexity and the circumstances, an activity is comprised of actions, the completion of which satisfies the original need. These actions are always realized in certain contexts; therefore, the existing conditions determine which specific operations will be implemented to materialize each action. Leont'ev's contribution, i.e., the differentiation between individual action and collective activity, constitutes the second generation of AT (Engeström 2014).

Engeström has further developed Leont'ev's AT (Engeström 1999, 2014), and cultural-historical activity theory (CHAT) has been advanced as a framework that encompasses the approaches of both Vygotsky and Leont'ev (Cole 1996; Cole and Engeström 1993). Engeström enriched Leont'ev's original triangle linking of a subject and object through a mediational tool with other components such as rules, community, and division of labor (Fig. 7.2). This new version of AT, which represents the third generation of AT, takes as its unit of analysis the "object-

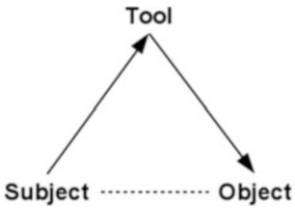

Fig. 7.1 The tool-mediated structure of human activity

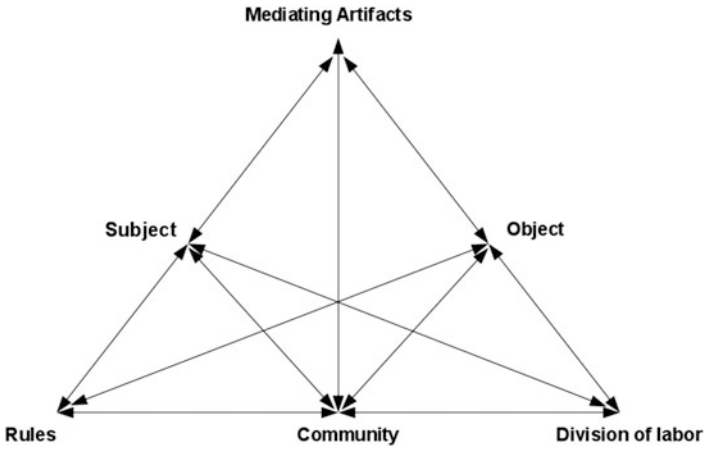

Fig. 7.2 Depiction of the main components of an activity system

oriented, collective and culturally mediated activity" (Engeström and Miettinen 1999, p. 9).

In its expanded from, AT is a theoretical framework ideally suited for the holistic study of human activity. Its value stems from its potential to represent the main constituents of human activity, overcoming the limitations of using the individual as the unit of analysis. The focus on object-oriented activity, which is pursued collectively, is a critical advancement as it addresses the distorted image of a solo individual. The second advantage of Engeström's conceptualization is the fact that such a comprehensive mapping of human activity enables the researcher to determine inconsistencies, friction, and conflict within the components of an activity as much as between components. In the course of two decades of work, a large set of published studies have applied the AT framework both in other areas and in education (e.g., Engeström et al. 2002; Russell and Schneiderheinze 2005; Sannino and Nocon 2008; Yamazumi 2008; Sannino 2008; Nocon 2008; Rasmussen and Ludvigsen 2009). For our purposes in this chapter, AT is a particularly useful theoretical framework for the study of educational reform in general and ICT-based innovation in particular. In the following section, we will explore the main implications of AT for reform by drawing on the available literature. It should be noted that, as a rule, the findings presented in the next subsection are from studies that employ theoretical frameworks other than AT.

7.9 Implications: ICT Reform Seen Through the Lens of Activity Theory

An activity system has a specific object. The whole activity system is configured to facilitate the pursuit of this object. A reform can be seen as a change that is introduced into a system, usually ending up disturbing it. Typically, the

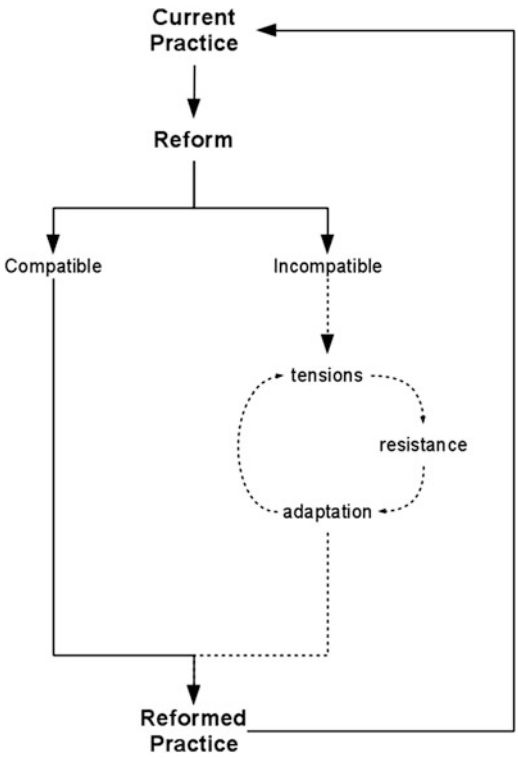

Fig. 7.3 A typical reform cycle

introduction of a reform will either introduce a new object of activity or modify existing components of the activity system. When the new meets the old, tensions arise in the form of conflict, and resistance to reform is likely. AT enables researchers to map out points of friction and determine what impedes innovation in a systemic manner. Depending on the context and the objectives of reformers, reform can take many *forms*: curriculum, resources (a special case of which is technology), exams-testing-evaluation, class size, time allotted, curricular organization, and instructional strategies. A generic life cycle of reforms is depicted in Fig. 7.3.

Incompatibility and disruption in the unlikely case that the reform is fully *compatible* with current practices, then it is adopted without further problems. This is the best-case scenario in which teachers adopt an innovation without complaints, concerns, or resistance. In this favorable scenario, the reform does not introduce tensions within or between the components of the activity system. In fact, if the reform helps pursue the existing activity object more effectively or efficiently, then it will not only be acceptable but even welcome. Innovation diffusion research has consistently confirmed compatibility to be one of the four main characteristics of innovations that influence adoption rates (Rogers 2003). Compatibility of the innovation in terms of values, past experiences, and needs is a critical adoption factor. Moreover, the aforementioned historical approaches have

also convincingly documented how the nature and the timing of certain reforms (such as the Carnegie unit) were easily taken up as existing practices were in need of standardization (Tyack and Tobin 1994). There have been quite a few notable examples of technologies that teachers have welcomed, such as the overhead projector (Cuban 1986) and more recently the video projector, presentation software, and currently interactive whiteboards (Beastall 2006; British Educational Communications and Technology Agency 2006; Cuban 2013).

However, if the reform is *incompatible* with current practices, tensions are unavoidable. We take a closer look at tensions in the next subsection.

7.10 Tensions

Generally speaking, tensions appear as any form of friction resulting from reform. Essentially, tensions are manifested in many guises such as difficulties, troubles, problems, friction, disturbance, conflict, and, generally speaking, as any negative sentiments associated with reform. In terms of AT, tensions indicate contradictions, either within or between the components of the activity system.

There are several examples of tensions in the literature, both concerning reform in general and ICT-specific reform. Regarding the former, Cuban (2013) details the introduction of new science curricula in the USA in the 1960s. As he argues, reformers changed the official curriculum (first layer), but this change had little influence on the taught curriculum (second layer). Neither did this reform influence what students learned from the taught curriculum (third layer) nor on the curriculum that was eventually tested (fourth layer). Essentially, the problem stemmed from the dichotomy of teaching about science vs. learning to do science. Interestingly enough, Cuban (2013) does mention gaps, discrepancies, and contradictions within and between these layers without adopting AT. Consequently, it is particular in such cases where AT can be most useful. In AT terms, there was a contradiction within the object of activity, as the reform introduced a new, markedly different object for science learning.

In her multiple case studies, Trumbull (1999) documented the problems that new teachers experienced as they entered the profession in their attempts to implement constructivist approaches to science. She reported several tensions that the new teachers experienced: (a) *teaching* (lecturing and expository teaching vs. project work), (b) *biology teaching* (memorization of facts vs. going beyond the facts and understanding the mechanisms), (c) *lab instruction* (cookbook-recipe labs vs. open-ended design labs), (d) c*urriculum* (specialized vocabulary vs. concepts), and (e) *curricular guidelines* (no curriculum guidelines vs. mandatory state exam with according curriculum). Much like Cuban (2013), Trumbull (1999) only mentions such contradictions without further theorizing them. In terms of AT, any diversion from the corresponding established approaches created tensions between existing (i.e., vocabulary memorization) and new objects of activity (i.e., conceptual understanding) as well as tensions between old (lecturing; cookbook-recipe labs) and new resources (project work; open-ended labs).

Turning to *ICT-specific* examples, one of the teachers in Windschilt and Sahl's (2002) study wondered: "How will this (i.e., Laptop) go into math?" (p. 183). This remark suggests that this teacher did not perceive technology as a resource to help with mathematics learning; that is, he did not see technology as a solution. Rather, he saw it as an add-on that he will have to figure out how to integrate in mathematics. That is, he viewed technology as an additional problem that he would have to resolve. Again, AT is helpful as it shows how the teacher experienced a conflict between a newly introduced mediational artifact (computer technology) and the object of activity (learning mathematics).

While the teachers in the Hennessy et al.'s (2005) study expressed commitment to ICT integration, they also expressed concerns centered on three major tensions. First, they complained about wasting time on ICT skills, thereby decreasing the amount of time spent on subject-specific concepts. Second, teacher concerns also revealed tensions between using ICT and conforming to the external pressures of traditional examinations. This is a major concern also highlighted in other studies (Li 2007; Chen 2008). Finally, the teachers realized that ICT had transformative effects, making some tasks easier, such that there was no thinking involved. In terms of AT, all three tensions indicate a contradiction between the object of activity (subject learning; exam scores) and the mediational means used (ICT).

In their study of how teachers took up ICT in their practices, Baggott la Velle et al. (2004) reported three major tensions. The first tension involved lab work: instead of capitalizing on the important features of simulations, the teachers viewed them as an impoverished version of practical work, which reflects a contradiction between object and mediational means. The second tension identified was related to the use of the Internet as an information source. The teachers viewed the Internet as a method of bringing currency to curriculum content. When employing the Internet as an information resource, however, the teachers realized that their students lacked the skills to interpret the information they gathered from Internet sources, a tension which reflects a contradiction within the object of activity.

When teachers see the curriculum as overloaded, then they might feel under pressure to cover the curriculum rather than use technology for teaching the curriculum. Baggott la Velle et al. (2004) found that ICT enabled students to take shortcuts, skipping the curriculum altogether. Teachers in the Eteokleous's (2008) study also expressed problems related to the curriculum: they reported that the curricular philosophy was not aligned with the progressive instructional practices which required a high degree of ICT integration. Along the same lines, Penuel et al. (2007) also reported that, if the ICT-based innovation is not aligned with district and state standards, problems might arise. In terms of AT, these examples of incompatibilities indicate tensions experienced by the teachers who either attempted or contemplated to use ICT. An example of such tensions is provided in Karasavvidis (2009) who examined primary teachers' views about the conditions under which Computer Supported Collaborative Learning (CSCL) could be integrated into their daily practices. The teachers mentioned lack of instructional time and curricular pressures as the main obstacles to such an adoption. Using AT as a theoretical framework, Karasavvidis (2009) detailed three major sources of tension between existing and CSCL practices.

Finally, as alluded to earlier, ICT will also have to be compatible with the dominant examination culture. If it is not, then tensions are highly likely. One of the teachers in Li's (2007) study stressed that what was essential for her was to make sure that her students pass the tests and exams. To this end, she preferred to spoon-feed her students from a book rather than use technology. A similar finding was reported by Chen (2008) who concluded that the primary goal of the school where he conducted his study was to prepare students for examinations. Consequently, the teachers refrained from using technology to conduct creative but time-consuming activities. As they explained, allocating class time for technology use was difficult. Again, seen from the AT perspective, these case of incompatibility suggest conflicts between the object of activity (subject learning as measured by the officially sanctioned test instruments) and the mediational means (ICT) which emerged when teachers attempted to integrate technology into their practices.

7.11 Resistance

When a reform is introduced into an activity system, teachers will necessarily need to respond, one way or another. Quite often, teacher responses take the form of resistance. Resistance may be implicit or explicit, active or passive. Teachers' responses to reforms may fall along the continuum between fully compliant and minimally compliant. This resistance might originate from the subjects of the activity per se (i.e., teachers), from the objects of the activity (i.e., students), or from other community members (e.g., parents or other stakeholders). The major sources of resistance are given in Fig. 7.4. In the remainder of this section, we will present the main sources of resistance to reform and discuss the relevant literature.

7.12 Teacher-Related Resistance

Teacher-related resistance can take one of two major forms, both of which are strongly interrelated. On the one hand, when asked about what impedes the realization of innovation, teachers often complain about *time*. On the other hand, teachers also express concerns about the *effort* involved to materialize reform.

7.13 Time

A typical manifestation of tensions is teachers' complaints about time. When faced with technology reform, more often than not, teachers will complain that they lack the time to implement it. As it has been noted, time acts as a "code word" for other troubles (Olson et al. 1999). In general, the history of reform suggests that the time involved in realizing a change might hinder its uptake (Rogers 2003, pp. 20–23). For instance, the failure of the Dalton Plan implementation in US education in the early 1920s was in part due to teachers' objection to the time involved in realizing it

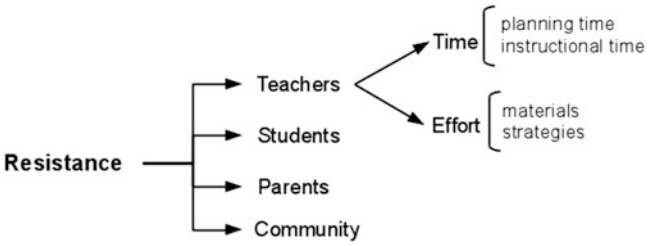

Fig. 7.4 An outline of the sources of resistance to innovation

(Tyack and Tobin 1994). The issue of time appears to be recurrent in ICT reform studies. Soloway et al. (2000) report that time was one of the conditions needed to facilitate ICT integration. Time was an obstacle frequently mentioned by teachers when asked about technology use (Condie et al. 2005). Likewise, Li (2007) reported that teachers believed that technology use demands time. Cuban (2013) concluded that teachers' resistance to technology can be partly explained by the sheer amount of *time* required to change classroom routines. Hayes (2007) also reported that successful integration of ICT by teachers depended on the availability of *time* to reflect on their current practices, to collaborate with their colleagues, and to experiment with new approaches to teaching. Similarly, Sandholtz and Reilly (2004) report that time was the resource most often requested by the teachers who needed time to learn, to prepare, and to experiment.

Generally speaking, the issue of time that teachers mention as a problem can be partitioned into two main categories: (a) *planning time* and (b) *instructional time*. *Planning time* is critical for teachers. Kennedy (2010) points out that the typical ratio of planning time to instructional time is 1:5. As she notes, in reality, this is significantly reduced, as the teachers need to perform several other duties—especially when they are at school. Consequently, teachers often have to resort to spending their own personal time (such as evenings, weekends, and holidays) for planning. Several studies on ICT innovation report planning time as a critical factor for ICT uptake. Lack of planning time has been reported by teachers in the Cuban et al.'s (2001) study. Angers and Machtmes (2005) concluded that teacher planning time was a key factor determining the extent of how technology gets used. In an ICT teacher-training context, Conlon (2004) concluded that time was the most sought after resource. Teachers need time to explore technology and develop their relationship with it (Beastall 2006), as well as to learn new materials and software (Kerr 1991). Often teachers request more time to plan for technology use (Sandholtz and Reilly 2004; Penuel et al. 2007; Windschilt and Sahl 2002). These findings suggest that *time outside class is required* and that teachers might not necessarily have this luxury. Technology seems to pose heavy constraints on preparation compared to other reforms. For example, more than 50% of the teachers surveyed in Voogt's (2008) study reported that the use of ICT had increased the time they needed for lesson preparation.

The amount of *instructional time* teachers have at their disposal for integrating technology is fixed. If technology takes up more time than teachers have available in a single period, then they may be reluctant to use it. Even early survey studies found that teachers devote considerable time and effort to teach with technology in their classrooms (Sheingold and Hadley 1990). Teacher concerns regarding instructional time can take various forms such as distraction (Granger et al. 2002) and waste of time (Hennessy et al. 2005; Chen 2008). These studies suggest that, when teachers are under pressure to cover all content, they are not willing to allocate class time for time-consuming technology activities.

7.14 Effort

Time concerns are often a function of the effort required, so teacher resistance is also expressed in the form of the effort expenditure that will have to be invested. Effort-related issues might refer to concerns about new materials or new teaching strategies. Therefore, time translates to the effort required for preparation (i.e., create materials) and experimentation (i.e., develop strategies, determine what works and not, and develop a teaching method).

Implementing an innovation calls for new *materials*. Searching, developing, gathering, or adapting materials requires a considerable effort by teachers. For instance, to create new materials to support an innovation, teachers might need to reconsider—among others—the curricular content that comes into play, the presentation materials, the tasks that are to be used for teaching the specific content, the homework assignments, and exam materials. As Trumbull (1999) stressed: "...finding new materials that support new teaching practices takes more time. Learning to modify or develop materials takes even more time" (p. 109). Overall, the amount of labor involved for developing and adapting new materials is not something that educators will take lightly. The history of educational innovations suggests that the reasons for failure are often related to the sheer amount of work that teachers have to put into implementing an innovation. Tyack and Tobin (1994) offer three telling examples of reform which failed because the demands made on teachers were far too labor-intensive. Cuban (2013) also attributed teacher resistance to the energy that teachers will have to use to materialize an innovation. Therefore, change throws teachers off their familiar patterns, making high demands in terms of effort.

A similar pattern emerges when one considers studies related to ICT-based reform. The situation is succinctly summarized by a teacher in the Office of Technology Assessment (OTA 1995) report. As the teacher stated, after many years of experience, he had figured everything out. However, if he were to start using technology, he would have to start from scratch, figuring everything out again.

Changing *instructional strategies* also involves considerable effort and might lead to teacher reluctance. Where there is a mandated curriculum that teachers need to cover within a given time frame, teachers tend to resist ICT-based reform

(Eteokleous 2008; Siorenta and Jimoyiannis 2008). This content coverage usually takes the form of time pressure: teachers explain that integrating technology into classroom activities would be very time-consuming (Chen 2008). In the Granger et al.'s (2002) study, time was one of the two most frequent obstacles to ICT implementation. Resistance to ICT was reflected in teacher concerns that time spent using technology was not devoted to the curriculum they had to cover. Implementing novel teaching strategies can be very demanding for teachers in terms of the time required. For instance Norton et al. (2000) report that using technology in mathematics class for learning about quadratic equations required exploratory learning which in turn required time for exploration. However, this time was unavailable because the teacher had to prepare her students for the upcoming tests.

Overall, AT helps conceptualize time-related teacher concerns and similar findings have been reported by AT-inspired studies. More specifically, Nocon (2008) identified time as a source of innovation-related conflicts. A similar picture emerges from Sannino's (2008) analysis which indicates that teachers were pressed for time regardless of their interest in continuing an innovation.

7.15 Resistance from Other Sources

Broadening the focus to include other participants reveals that, in addition to the subjects of the activity system (teachers), both the objects (students) and the broader community (parents and other community members) might have to resist reform. To date, the literature has almost exclusively focused on teachers. Interestingly enough, however, as some studies indicate (e.g., Tyack and Tobin 1994; Cuban 2013; Trumbull 1999), it is not just teachers who might be reluctant about reforms. It is often students, parents, and other stakeholders who might oppose innovation.

With respect to *student resistance*, students have also developed expectations regarding the conduct of lessons, so reforms affect them as well. Tyack and Tobin (1994) discuss two reforms that student resistance helped overturn. In the first case, the Dalton Plan reform, the innovation was largely student-centered, granting students more responsibility and freedom than traditional approaches. Resistance also came from students who complained that solitary and independent work was more boring than typical classwork. In another innovation examined, the High Schools of Tomorrow, Tyack and Tobin (1994) concluded that the innovation did not work well with students who had learned to work in a more directive environment. While some students enjoyed having many choices and free time during the school day, students lacking the basic skills for independent work struggled. A second case of student resistance is vividly illustrated in Trumbull's (1999) study. In their attempts to materialize constructivist science pedagogy, the new science teachers who participated in her study tried out various innovative approaches to teaching such as open-ended homework assignments. As the novel assignments were different from the variety to which the students were conditioned, the students

complained. Because the students lacked the required skill sets (e.g., comprehension strategies), completing open-ended assignments (such as find an article about genetics in a newspaper and write a one-page summary) was very demanding. To date, we are not aware of any studies detailing how students respond to ICT-based innovations. As a rule, student voices are unexplored so the corresponding student perspectives remain undocumented.

Parental resistance is also important as far as innovations are concerned. Tyack and Tobin (1994) discuss two innovations that were subverted with the aid of parents. In the first case (Dalton Plan reform), eventually the parents were among those who expressed discontent with the reform measures, complaining about the decline of motivation and discipline of students. In the second case (High Schools of Tomorrow reform), the flexibility of the reform was not particularly welcomed by parents, as it deviated drastically from what parents deemed to be a "proper" high school (Tyack and Tobin 1994). As a rule, parental voices regarding ICT reform are not documented. In what appears to be a notable exception, Chen (2008) reports that *parents* exert pressure on teachers, which eventually impedes technology use. In fact, Chen (2008) concluded that parental pressure is a substantial obstacle to technology integration. As he put it: "Various types of pressure might compel or even force teachers to resume lecture-based instruction and repetitive practice" (p. 71).

7.16 Adaptation

The last stage in the life cycle of reform is adaptation. A reform might create tensions that might lead to resistance and, eventually, adaptation. When teachers are confronted with an innovation, they only have two alternatives: either support it or subvert it (Hodas 1996). In terms of AT, the subject (teachers) will attempt to ease the tensions that arise from reform. One frequent problem with the adoption of reform is fidelity, as the reform might be reinvented (Rogers 2003). What this means is that the reform that teachers eventually adopt might not be exactly what reformers initially had in mind when they conceived the reform.

Non-ICT-related reform research has indicated that teachers tend to reject approaches that are incongruent with their beliefs or that do not fit with existing instructional practices. For instance, Coburn (2004) examined reading comprehension innovations in a US state over a period of three decades. Teachers interpreted reading-based innovations in terms of their existing practices and fitted innovations in their practices, even though if it meant that the innovations were distorted in order to fit current practices. Tyack and Tobin also discuss (1994) how teachers transform an innovation when applying it in practice, to the extent of subverting it or changing altogether. Cuban (2013) has also provided several similar examples of reforms that teachers adapted to their practices, often denaturing the reform per se.

A similar pattern regarding adaptation emerges in the case of ICT-based reform. As opposed to revolutionizing current practices, ICT has been basically assimilated into them. In summarizing the impact of computers in classrooms over the first

decade of their introduction, Cuban (1993) concluded that the classroom has won, i.e., it has assimilated computer technology rather than computer technology having transformed classroom. Cuban has reached the same conclusion in follow-up studies (2001, 2013). As already discussed in the introductory section, the literature finding that ICTs are mainly used to sustain current classroom practices is consistent (e.g., Hennessy et al. 2005; Donnelly et al. 2011; Player-Koro 2012; Voogt 2008; Yang 2012; Hayes 2007; Hermans et al. 2008).

Summing up, as a framework, AT can be used to interpret the tensions-resistance-adaptation loop depicted in Fig. 7.3. On the one hand, in terms of AT, the established practices which weave the material conditions in which teachers operate can be seen as dominant activities (Sannino 2008). In this regard, an innovation can be seen as a competing, nondominant activity, striving to displace the dominant activity and its object. Additionally, adaptation can take the form of a hybrid activity system (Yamazumi 2008), which results from the interplay between the dominant activity and the innovation that is introduced. Resolving tensions may be considered as a hybrid activity that often emerges as a viable alternative for teachers.

7.17 Discussion: Reconceptualizing the Barriers to ICT Integration

In the first section of this chapter, we reviewed the current status of ICT integration in education. As the research literature suggests, ICT integration is characterized by two main problems: (a) the extent of ICT use is low (Fraillon et al. 2014; Law and Chow 2008; Zhao and Frank 2003), and (b) whenever used, ICT is integrated in ways that sustain rather than transform current practices (British Educational Communications and Technology Agency 2008; Fraillon et al. 2014; Gray et al. 2010; Donnelly et al. 2011; Player-Koro 2012; Voogt 2008). The dominant view regarding ICT reform was then presented. According to this pragmatic conceptualization, two main clusters of barriers to ICT are identified, first-order and second-order ones (Ertmer 1999, 2005). As we pointed out, the pragmatic conceptualization has two important limitations, inappropriate unit of analysis and individual-blame bias. To address these limitations, we turned to two alternative theoretical perspectives on reform.

Firstly, we examined the historical perspective (Cuban 2001, 2013; Tyack and Tobin 1994). Using a historical analysis, this perspective highlights the importance of contextual factors for understanding reform. Important insights can be gained from the study of how reforms evolve in context. We have reviewed the literature to document how contexts are critical for understanding ICT reform. The main contribution of the historical perspective is that it stresses the importance of context and history, extending the unit of analysis from individual teachers to the broader contexts in which teachers work. As we argued, the main implication of the historical approach is that it helps reframe the problem of ICT integration from a singular issue to a contextual one. Despite the insights that can be gained from the

historical perspective, we identified two main limitations: (a) the lack of specification of the unit of analysis and (b) the lack of theory to untangle the notion of tension and show its source, dynamics, and consequences. To address these limitations, we turned to AT which can greatly compliment the historical perspective.

AT enables (a) a systemic approach to practices and (b) an account of the tensions emerging from reform implementation (Engeström 1999, 2014; Cole and Engeström 1993; Engeström and Sannino 2010). Unlike the historical perspective, the AT toolkit offers a more concrete unit of analysis, one that facilitates a systemic examination of contexts. Using an object-oriented activity system as a unit of analysis, AT helps examine reform in systemic terms, namely, as an evolving change that involves various interacting agents (teachers, students, parents, administrators). In this regard, AT helps reframe the ICT integration problem as in systemic rather than singular terms (Engeström 2008). Furthermore, AT allows us to uncover the tensions introduced by reform, to identify the sources of these tensions, to explore how teachers experience these tensions, and to respond to them. The main implication of this framework is the mapping of contradictions and resistance that are related to reform. In this regard, we presented several examples from the literature which illustrate tensions, resistance, and adaptation.

Now that we have introduced the two frameworks and delineated their implications, it is time to revisit the pragmatic conceptualization of the problem of ICT integration. As opposed to viewing the problem of ICT uptake in education as an individual teacher issue, we argue that it needs to be seen in more systemic terms. It is insufficient to focus on teacher views and hope that changing teacher views about ICT will naturally and necessarily lead to integrating ICT in their practices in the desired manner. Thus, we propose yet another type of barriers, *zero-order barriers* (ZOBs). We call them zero-order barriers because they represent obstacles that, though less obvious, are even more fundamental than the first-order barriers. In terms of the current barrier conceptualization (Ertmer 1999, 2005), ZOBs refer to the systemic factors that either remain unaccounted for or are misguidedly categorized as first-order barriers: time and effort required rules and legislation, historical traditions, curricula, and examination cultures. In the pragmatic conceptualization, ZOBs are typically mixed together with factors that just determine the physical, "hard" constraints of ICT integration. It should be noted, however, that ZOBs are different from first-order barriers because they constitute contextual forces that shape second-order barriers in their interplay with first-order ones.

More specifically, a simple change in ideas lacks the institutional power to legitimize change in the corresponding material conditions that define teachers' practices. As we discussed, teachers experience various forms of pressures, which lead them to set specific priorities. More often than not, these priorities are not aligned with the priorities of other stakeholders (administrators, policy makers, academic researchers). Teacher concerns regarding time and effort will have to be addressed. Therefore, in addition to changing teacher views, reformers will need to take other measures to change the material conditions which constitute teacher

practices. That is, reformers need to explicitly deal with zero-order barriers. By introducing ZOBs, we mean to emphasize the importance of the material conditions which shape teacher priorities and corresponding practices: rules and legislation, historical traditions, curricula, and testing cultures. We claim that it is only such changes of ZOBs that can modify the material conditions of practice and provide the requisite degrees of freedom to educators for implementing reform. Adopting Cuban's (2013) metaphor, much like sailors need to pay very close attention to coral reefs, educational reform stakeholders (educational administrators, policy makers, and academics) will also need to take into consideration the material conditions which define teacher practices.

We accept that in some contexts, where the situation is conducive to reform and the overall climate is supportive, changing teacher views about the value of ICT will suffice to achieve the desired level of ICT integration. In such cases where success is entirely dependent on teacher views, there are practically no ZOBs. However, in the majority of contexts, simply changing teacher views will not necessarily lead to the desired ICT uptake. Based on the consistent findings of the long history of educational reform, changing teachers' views about ICT might constitute a necessary but not a sufficient condition. If reform efforts fail to address the material conditions which characterize teacher worlds, then the fate of reform will be largely predictable (Sarason 1990, 2002). As the literature shows, teachers will either comply minimally, domesticating the innovation, or strongly resist, denaturing the innovation. Thus, we argue that changing the material conditions of practice, i.e., resolving ZOBs, needs to become a top priority for reformers.

Ertmer's (1999) distinction between ICT integration barriers that are related to teachers and barriers that are not related to teachers puts teachers into the spotlight, ostensibly stressing their agency. As we pointed out, however, this potentially leads to their victimization because they will take the blame for any ICT integration failures, as the experience with previous reforms indicates (Sarason 2002). On the surface, ZOBs appear to downplay teacher agency as factors unrelated to teachers (e.g., rules and legislation, curricula) are considered to be of primary importance. However, we argue that the concept of ZOBs advanced in this work essentially addresses the core of teacher agency. For example, some highly motivated and committed teachers can be remarkably innovative even in the most rigid and unsupportive environments, managing to overcome all sorts of obstacles. These teachers approach contexts actively and end up redefining them—even if it means paying a high price in terms of time and effort expenditure. The problem is that these teachers are only a small minority. As Cuban (2013) points out, being a teacher in a US charter school today practically amounts to nothing short of being a "superhero." He concludes that the expectation that schools are staffed by superheroes is unrealistic. After all, superheroes do not come in large numbers. Ironically enough, it only makes sense to talk about a "superhuman" only when the demands posed by the task far exceed human capabilities. Thus, ensuring that the task demands of teaching practices remain within the grasp of humans practically ensures that rank and file teachers will implement it successfully.

7.18 Limitations

We see two main limitations of our work. First, the concept of zero-order barriers is not supported with our own empirical data. It should be noted that, initially, the concept of ZOBs originated from the analysis of data in one of our former studies (Karasavvidis and Kollias 2014). However, for the purposes of introducing our argument, we deemed it more appropriate to draw on the large pool of empirical studies. We see the converging evidence from various studies as especially promising for our ZOB conceptualization. Our future plans involve the analysis our own data for a more fine-grained account of ZOBs.

Second, to advance our argument we have been very selective drawing on two frameworks, Historical and AT. On the one hand, we have chosen to use only certain concepts from these frameworks, freely combining the two as we saw fit. On the other hand, in our attempt to piece the puzzle of ZOBs together, we have chosen not to be critical of these frameworks. Thus, we have deliberately decided to use them as complimentary, conveniently ignoring their inner limitations (e.g., Rasmussen and Ludvigsen 2009) or even the possibility of their theoretical incompatibilities. Again, our goal in this work was to formulate a first version of our argument rather than examine each framework.

7.19 Conclusion

The failure of educational reform has puzzled educational researchers, administrators, and policy makers for a long time. The same holds for ICT-based reform. The pragmatic conceptualization of ICT integration introduced a practical distinction of barriers in first- and second-order ones. In an attempt to address the limitations arising from the pragmatic conceptualization, we introduced two theoretical frameworks, historical and activity theory, and explored their implications for the problem of ICT integration. To explain the problem, we introduced the construct of zero-order barriers (ZOB). We argued that ZOBs facilitate the understanding of ICT reform as they help uncover what transpires in practice. As we suggested, once teacher voices are taken into account, their views and priorities emerge, revealing the material realities that define their practices. Unless reformers take measures to explicitly address these realities, thereby changing the material conditions which shape teacher practices, the failure of educational reforms is predictable (Sarason 1990).

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