Article:
Perrotta, C and Evans, MA (2013) Instructional design or school politics? A discussion of 'orchestration'in TEL research. Journal of Computer-Assisted Learning, 29 (3). 260 - 269. ISSN 0266-4909

https://doi.org/10.1111/j.1365-2729.2012.00494.x

To appear in JCAL – Journal of Computer Assisted Learning

Accepted 24 Jul 2012

Instructional Design and the Politics of Schooling: A Discussion of "Orchestration" as a Metaphor for Teaching in TEL Environments

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Abstract

This paper argues that the emphasis on orchestration as a metaphor for teaching in technology-enhanced learning (TEL) environments, featured in recent academic discussions, is an opportunity to broaden the scope of the inquiry into educational technology. Drawing on sociological literature and research that investigated the systemic factors that influence the uptake of ICTs in formal and informal learning contexts, the paper contends that a focus on instructional design does insufficient justice to the complexities of actual technology use in classrooms and after-school programs. It is suggested, instead, that orchestration might better be used as a heuristic device to deepen our understandings of the relationships between power, bestowed on teachers or claimed by them through a number of strategies, educational technology, and teaching practices. The paper concludes that to fully understand this relationship and to support teachers, concern should be given equally to the existing political and cultural dynamics of TEL environments. Examples of orchestration as a political, cultural process are provided, illustrating how teachers appropriate technology and "innovative" pedagogies to negotiate power.

Keywords: orchestration, power, video games, informal science education, learning-by-design

Orchestration, Power, and Educational Technology

Orchestration as a metaphor for teaching is gaining increased attention in the technology-enhanced learning (TEL) community as thought-provoking views emerge in favour of or against its formalisation as an actual theory (Perrotta et al. 2011). The term is not particularly new in educational research, and it has been used often in approaches with a strong emphasis on instructional design. For instance, Brown (1992) wrote about orchestrating classroom activities in the late twentieth century when introducing design experiments. Watts (2003) also provided a critical examination of the use of this metaphor for educational purposes, arguing that whilst a teacher can certainly be seen as the leader of an ensemble of students, seeking to produce a concerted performance from a diverse group of players, it is also important to remember that, like all metaphors, orchestration "has a range, a frame of reference, inside which it has some meaning, but beyond which it begins to falter and fail."(p.452). The term has lately seen something of a resurgence in the context of TEL, where it is being used to reconfigure (and, in a very real sense, reintroduce) the role of teachers along lines defined by instructional design and by the need to increase human control over the range of complex socio-technical dynamics that occur in actual classrooms and after-school settings (Dillenbourg, Järvelä, & Fischer, 2009). The authors have been engaged in a yearlong exploration of the meaning and relevance of the orchestration metaphor with colleagues from the UK and the EU, this article being one result of those meetings and conversations (e.g. Kollar et al. 2011).

Historically, the advent of computing in the field of instructional design and the popularity of "student-centred" models of learning have been associated with techniques that tried to reduce the centrality of teachers in the instructional process, by turning them into "guides on the side" or "tutors" or "scaffold providers" expected to facilitate student-centred activities, while machines would perform many of the functions previously within their

sphere of control, in particular, diagnosis and assessment (Means, 2006). In some cases, TEL environments were explicitly or implicitly built to be "teacher proof", so that a learner would be able to perform activities independently, whilst issues associated with the variability of teachers' skills and levels of competence could be reduced. A recent example is the use of "scripts", which were developed in the field of CSCL (Computer-Supported Collaborative Learning) as a model of instruction to be internalised by the students through interaction with a machine and with other peers. A script is therefore a psychologically oriented instructional technique that typically describes what to do and how to do it at different stages of a collaborative process, e.g. expecting a student to state a hypothesis and then prompting a peer to produce counter-evidence, thus helping both internalise an effective model for self-regulated scientific argumentation (Weinberger, Stegmann & Fischer, 2007).

Now, the student-centred paradigm has sparked some controversy amongst researchers as well as policy makers in the last few years. This controversy has had implications on different levels, impacting as much on research agendas in academic circles, as on the ways schools in some countries (e.g. in the UK) are being evaluated and re-organised. Whilst academics have been debating about the empirical foundations of student-centred learning, practitioners on the ground have been arguably caught in the middle of a political struggle, between calls for transformation and innovation and more conservative forces upholding the importance of traditional instruction to increase overall standards in key subject areas. To teachers' credit, they have been innovative and worthy of praise (at least, in some cases) for navigating these opposing priorities in an effort to provide engaging contexts for students (Evans et al. 2012). As such, notions of student-centred pedagogies, seen as forms of "minimally guided learning", have been criticised from a psychological perspective, on the grounds of their incompatibility with human cognitive architecture (Kirschner, Sweller & Clark, 2006), and from a comparative education perspective, following on findings

emerged from large scale evaluations, which illustrated how the quality of teachers is one of the main factors influencing the overall performance of an educational system (OECD, 2009, 2010). We would like to suggest that the introduction of the term orchestration in TEL research needs to be seen against this backdrop, as a way to communicate a renewed appreciation for the role of the teacher in the learning process, who now comes to be seen as an "orchestrator": an empowered figure coordinating a broad range of technology-enhanced activities.

"Orchestrating Learning" is also one of the "Grand Challenges" identified by The European network STELLAR (Sustaining Technology Enhanced Learning at a LARge scale), which brings together researchers from diverse scholarly communities to address emerging trends in technology-enhanced learning. According to this challenge, research ought to explore further the role of the teacher or the more knowledgeable other, to design more powerful instructional models capable of adapting to the changed and more complex circumstances of formal and informal education in the 21st century. The discussions and debates that took place in the context of STELLAR were particularly useful to develop the view explored in this paper (Kollar et al. 2011).

In summary, orchestration can be regarded as a response to a trend in academia, but also in the wider educational discourse in Europe and beyond, that seeks to reinstate the centrality of the teacher in formal and (where appropriate) informal educational contexts. Dillenbourg and Jermann (2010) explicitly refer to orchestration as a "teacher-centric approach" (p.1) to stress the elements of proactive guidance, which may be interpreted as an explicit remark on the frustration with a radical notion of discovery learning or experientially based learning, which has been mentioned above. Other factors, more specific to the field of TEL, also contributed to the emergence of orchestration as a proposed construct, most notably a rising awareness of a gap between "state of art" experimental studies on learning

and technology, and the "state of the actual" (Selwyn, 2011); that is, the messy realities of schooling where compromise, pragmatism and politics take centre stage, and where the technological transformation promised by enthusiasts over the last three decades failed to materialise. This, arguably, is one point made by Dillenbourg when he refers to orchestration as a "flag for those who want TEL to have more impact in schools" (2011a, p.18).

Metaphors, Theories and Heuristics in Technology-Enhanced Learning

Metaphors are often problematic. As notably pointed out by Anna Sfard (1997), excessive and inflexible devotion to a metaphor is likely to lure researchers into debates focused on unproductive analogies among, potentially, incongruent domains, and to undesirable consequences for educational practice. On the other hand, metaphors can draw attention to hitherto underspecified aspects and phenomena, and can be useful tools to stimulate scholarly discussions by providing a more palatable "common-sense" heuristic framework for interpreting and communicating complex themes and dry empirical findings (Lakoff & Johnson, 1980).

In this sense, Dillenbourg's suggestion to drop the metaphoric claims of orchestration, to avoid a simplistic and likely to be erroneous equation between classroom instruction and the work carried out by an orchestra conductor, seems a reasonable one. Dillenbourg's alternative proposal is to use orchestration in a way that is more akin to the notion of heuristic device, that is, a tool for thinking differently about complex phenomena or, as Dillenbourg reasons: "a concept on its own. This concept is useful because it refers to things that have been neglected in TEL design" (2011a, p.20).

We would like to contribute to this discussion of orchestration, whether it be deemed metaphor or concept on its own, by offering a critical read: one that is not aligned with an unquestioned emphasis on instructional design efficacy, which seems to be a defining

element of current views on orchestration (taking scripting as one oft-cited example), but instead places power as central to the understanding of how teachers successfully (or not) orchestrate TEL environments. Our hope is that this critical perspective might clarify a few key assumptions defining more clearly the broader challenges faced by the TEL community in adopting orchestration as a useful construct. To assist in conveying our point, we share excerpts from two case studies, one in a formal classroom and one in an after school setting, where orchestration-as-power was found to be an appropriate and useful heuristic to interpret the power-related dynamics at play.

Reflecting on how to "design for orchestration," Dillenbourg (2011a) highlights an emerging consensus that orchestration is about accounting for a new level of constraints, which generally refer to practical difficulties in conducting TEL activities in learning environments: the "logistics" and other pragmatic aspects such as time management and usability. "A set of concrete issues that may bring a teacher to say that an approach 'works well' in his classroom" (2011a, p.4). Over and above the pragmatic and emergent issues that arise when TEL activities do not proceed "according to plan", there obviously is a set of higher-level constraints, which have been explored in the literature on ICT use in formal learning contexts (e.g. Pelgrum & Law, 2003): narrow curricula, contested time, rigid assessment regimes. These constraints are generally viewed as elements of a complex ecosystem where the actions of individual teachers, with or without technology, are influenced by what happens outside the classroom: from the broad level of educational policies, to the school level where accountability mechanisms and assessment regimes influence teaching and learning practices (Zhao & Frank, 2003).

In this sense, orchestration has been conceptualised as an "expansion" of instructional design (Dillenbourg, 2011a; Dillenbourg et al. 2011b). According to Dillenbourg, for too long instructional design has been concerned only with the "core instructional sequence"

(2011a, p.11); what he, borrowing from computer science terminology calls the "kernel", neglecting the "many things happening around the kernel" (2011a, p.11). These things include unpredictable occurrences, like student absences and technological failures, as well as the non-negotiable constraints of formal schooling like assessment and a limited school day with a prescribed timetable. While these additional layers surrounding the "kernel" of instruction can be controlled during experiments, they systematically and unpredictably intervene in naturalistic conditions and may explain why findings from experimental studies are rarely reproduced in schools. Hence, Dillenbourg concludes that:

> "These elements belong to the reality of school; anyone knows that. My point is that our community won't have a major impact without turning them into design principles. We cannot neglect the kernel but have to consider these rings, even if some issues mentioned seem to be just about the logistics**."** (2011a, p12).

Dillenbourg goes on to formulate a number of "design principles" that could facilitate orchestration by "integrating constraints into design" (2011a, p.21), thus illustrating how CSCL (Computer Supported Collaborative Learning) could be more effective in helping teachers manage those constraints. These principles boil down to the re-definition of orchestration as "usability at the classroom level*"* (2011a, p.20) or as the "third circle of usability" (Dillenbourg et al., 2011b). While the first circle is concerned with individual usability, and the second circle is about design for small and medium-sized groups, the third circle is concerned with the "whole classroom as a user" and with the development of a design paradigm that incorporates the related processes and constraints, thus reducing the "global orchestration load" for teachers (2011b, p.510). As Dillenbourg et al reason:

"At Circle 3, teachers have to cope with many constraints: curriculum relevance, time budget, time segmentation, physical space, discipline, security, etc. Understanding the relationship between CSCL design and the management of these constraints is what we refer to as usability at the classroom level" (2011b, P.512).

In this paper, we agree that the identification of low-level and high-level "constraints" is undoubtedly a pre-requisite of any discussion about the meaningful use of technology in the classroom. In this respect, orchestration might be the vehicle through which a "systemic angle" that considers the relationship between factors at the micro, meso, and, possibly, macro level can be accounted for in TEL research, this approach having been explored by one of the authors from a human performance technology perspective (Evans et al. 2012).

This alone would be a welcome addition in a field that thus far has been largely concerned with the formalisation of instructional processes through the language of design and computer science, and where the social dimension has mainly been associated with the analysis of collaborative dynamics in small and medium-sized groups (e.g. Laurillard, 2012). Hence, orchestration, whether as fledgling theory or simple heuristic device (or "concept on its own"), finds a purpose in the need to support and empower teachers, not by advocating a return to a prescriptive didactic approach, but by helping them recognise and address the issues, as well as the opportunities, brought about by a number of systemic and local constraints. It is in this purpose that orchestration simultaneously comes into its own and exposes its limits as a framework or reference for instructional design in TEL environments. By drawing attention to the issue of power, orchestration may, in fact, highlight the tensions and contradictions that surround teaching and learning more broadly, most notably that teachers are subjected to varying conflicting demands and expectations (cf. Bowman, 2004; Chaptal, 2002), while simultaneously acting according to personal ambitions, values, and

predispositions towards technology. These elements become no more apparent than when technology is introduced into the classroom, and they configure schools and classrooms as deeply political spaces where the use (or the non-use) of technology is surely dictated by individual skills and traits, but equally by a range of institutional enablers, organisational processes (e.g. hierarchical relationships and reward mechanisms), cultural expectations, shared ideologies and beliefs. While some of these factors are within teachers' sphere of control, others are most certainly without. In other words, teachers are just as much "used" instrumentally according to plans laid out by others (e.g., by delivering curricula, or executing assessment routines), as they are agents pursuing their own goals and interests: they are orchestrated and orchestrators at the same time. In light of this consideration, attempting to merely assimilate or integrate "issues and constraints" within an instructional process, reducing orchestration to a discussion about usability at the classroom level, may be an elegant and attractive form of inquiry, but also a rather limited one. In fact, it could be argued that such a course of action would represent a missed opportunity for the TEL community to enlarge the theoretical scope of its scholarship, as the notion of orchestration is simply reframed and "reconstructed" along the traditional theoretical lines of computer science, CSCL and instructional design.

Conversely, a focus on how individuals and groups move and act "politically" within those constraints, according to differing and sometimes oppositional agendas, might yield equally valuable and possibly novel insights, which could be used to inform more sophisticated attempts to influence teaching practices, based on negotiation and dialogue with practitioners rather than the imposition of "expert-validated" instructional models. For instance, as noted by Selwyn (2011), any discussion of ICT use in real classrooms cannot eschew the issues and the contradictions that surround teaching as an occupation, with all the struggles, tensions and negotiations that labour and work entail. As he points out:

> "the (non) use of digital technologies in school must be understood (at least in part) in terms of teachers' ongoing negotiations of their day-to-day work- a process that involves meaning-making and fitting various technologies with the "job" of being a teacher and, conversely, fitting the "job" of being teachers with the demands of digital technology" (Selwyn, 2011, p. 103).

If we position orchestration as a concept that might grant us greater insight into these day-to-day workings of teachers and learners, then it deserves further attention and refinement. In particular, we would like to suggest that the notion of orchestration represents a valuable opportunity for the TEL community to examine how technology-related agency in schools may be shaped by problematic motives and factors, which often relate to dynamics of power rather than issues of design and usability. By following this line of inquiry, we suggest that orchestration is indeed an opportunity to draw on a more diverse theoretical background than the one usually considered in TEL scholarship. In particular, we believe that theories concerned with power and conflict, and theories that view social reality as shaped by broader cultural and symbolic factors may have something to offer to our understanding of technology-enhanced learning in real classrooms. For instance, there is a long and established tradition in the social sciences concerned with the study of power in its different guises, which has shed light on the conflicts and contradictions that beset institutional contexts, schools included (e.g. Foucault, 1979); radical approaches to pedagogy also have explored relationships of oppression and resistance in education (e.g. Freire, 1985); insights from theories of rational choice can be no less effective in providing valuable insights into the negotiation of power through educational technology (Dowding, 1991). It is impossible to cover here these theoretical views to any great extent, since we aim only to

offer a glance of what might arguably represent a more theoretically rich approach to researching the micro-politics of technology use and non-use in the classroom and other informal learning settings. We are also not advocating one particular theoretical view over another, but merely suggesting that there is a whole body of knowledge "out there" that could dramatically enrich our understanding of educational technology use in situ.

An important caveat needs to be inserted at this point. By suggesting that orchestration is an opportunity to "enlarge" the theoretical scope of TEL scholarship, we are aware we are also limiting its remit as a notion capable of generating research; in other words, our proposal of "orchestration-as-power" implies that there are certain things that this notion cannot and should not aim for. More specifically, we are suggesting to position orchestration outside of the current theoretical edifice of CSCL and instructional design; as such, orchestration might fit less with the idea of educational research as a form of "intervention" that seeks to identify causal relationships between variables (i.e. technology, individual differences) and learning outcomes. Conversely, we see orchestration as aligned with a notion of educational research that is not only concerned with the effectiveness of educational means and techniques, but tries to develop a more nuanced understanding of the social – and indeed political – contexts that surround those means and techniques (see Biesta, 2011). Hence, it is argued here that orchestration better serves our scholarship as a lens for investigating why teachers, pulled between externally sanctioned objectives and internally motivated values and beliefs, choose to orchestrate technology-enhanced environments in certain ways instead of others. To illustrate this point, we will discuss in the next section two accounts of how technology-enhanced learning becomes a "site" where power is negotiated and contested.

Orchestration in the Formal Classroom: An "Innovative" Lesson in 2011

The following lesson was observed as part of an ongoing study into the conditions that enable innovative teaching and learning in English schools (Perrotta, 2012). Beyond its official aim, the study also highlights the ways in which individuals tend to use educational technology, and, generally, the discourse of innovation for political purposes. For instance, to accrue individual benefits, to enhance opportunities for career development, or more often as a form of harmless "resistance" to escape the drudgery of daily teaching, with its boring and stultifying routines, and pursue individual interests and passions. This particular lesson was part of a media literacy program running across several subject areas, and it had been described beforehand by the head-teacher as an example of the innovative work carried out by some teachers at the school. The broad framework was provided by "Opening Minds", an approach to cross-curricular learning developed by the British RSA (Royal Society of Arts)[1]. During the lesson students were creating blogs in real time, performing web searches under the guidance of the teacher, and organising the draft content that they would investigate and refine at a later stage as part of their personal projects. The aim was to develop a digital output – an online journal - which would reflect progress across a number of subjects, gradually turning into a dynamic learning record for the whole academic year and a repository of useful information for other students, in the school and beyond. The blogs were developed using the open source blog software WordPress. Blogs were also linked to the students' Twitter feeds with the aim to increase the sense of personal ownership. The most interesting thing about the lesson was not the actual instructional process, in itself nothing more than a guided discussion supported by real-time access to information on the web, but the fact that the teacher had clearly "orchestrated" the situation skilfully to focus the lesson on themes close to his heart. For instance, he had decorated the classroom walls with posters

[1] http://www.thersa.org/projects/education/opening-minds

of the teacher union, and the lesson was taking place only a few days before a large industrial action of public workers – teachers in particular – concerned about the controversial pension reform planned by the government. The teacher had taken advantage of the opportunity afforded by the "opening minds" framework to discuss issues of pluralism in the media, and the way different outlets were likely to report the imminent strike. The teacher had gone out of his way to book individual laptops to be used in the classroom, and spent a frantic 20 minutes before the beginning of the lesson to ensure that the Wi-Fi connection was stable and that the firewall settings were customised on each laptop to relax the restrictions placed on student web-searches. He was certainly performing specific actions to address the logistic issues and hurdles that normally arise when technology is involved, but again this is not what was really noteworthy about the situation. What was really interesting was the energy and the commitment shown by the teacher in dealing with such issues, as well as a sense of personal empowerment as he was trying to do "something different" and possibly even controversial, with the aim of passing on some of his passion for politics and the social science to his students.

Orchestration in an after-school setting: High school students designing video games

From November 2010 to March 2011, a group of twelve high school students in the mid-Atlantic United States participated in a series of ten after-school game design workshops, held twice-weekly for 45-60 minutes each, assisted by four graduate students from a local university as reported in Evans, Jones & Akalin (2012). The formal classroom science teacher, Mrs. Johnson, served as co-principal investigator, project coordinator, and scientific advisor to the reported project. Mrs. Johnson scavenged personal leave days as well as free time during the school day, e.g., saving time during her normal planning hour, to prepare and work on the project. She donated time in the after-school setting to serve as the science advisor in most of the sessions, exemplifying her commitment to bring innovative

TEL experiences to her class despite evident institutional barriers and few explicit professional incentives.

The goal of the project, called Mission: Evolution to explicitly depict the mash-up of video games and science education, was to incorporate video game play, and video game design into the established state-sanctioned curriculum, to establish an informal science learning experience that served as primary mechanisms to engage students in topics in evolutionary biology. Through game play, using the video game Spore[2] as the primary reference, students were guided by the teacher through customized hand-outs to encounter examples and non-examples of evolutionary biology in the video game and reflect on the consequences of their actions on the evolution of their avatars. The purpose of this portion of the learning experience was to engage students in critical reflection as they judged the veracity of science conveyed through Spore, inspired by noted challenges of rigorously conveying science through a medium that is also inherently entertaining (Bohannon, 2008). Through game design, which was accomplished by using the WYSIWYG level-builder provided in Spore: Galactic Adventures[3], students were compelled to, first, learn how to manipulate the level-building tools provided by the game environment and, second, appropriate these tools as they developed their personal video games without seriously violating scientific understandings of evolutionary biology.

The workshop scenario as depicted could well be analyzed using the language and the notions of instructional design but one is left with a potentially sterilized understanding of how the workshops, in fact, unfolded over the designated weeks in the late fall and early

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2 http://www.spore.com/sporepedia

3 The level builder can be seen in action in this video http://www.youtube.com/watch?v=xJ2_qNDgvOs&context=C3409bf1ADOEgsToPDskIVULb1c3pur1AHmAgXlkfS

spring semesters. What this type of conventional analysis lacks is a deeper understanding leading to a rich characterization of the interactions and relationships among teacher, learners, facilitators, and technologies. A specific instance that requires attention, one that highlights the integral place of power in this TEL dynamic, is the tension between a fun video game and an educational (or serious) one. Teacher and learners worked through (up to) three iterations of design documents as the teacher insisted on maintaining the scientific rigor of deliverables while students countered by stating that they just wanted to make the games "fun." Struggle between criteria of fun and educational belies tensions along several dimensions. On the one hand, the teacher was concerned that if any invalid or inaccurate scientific ideas were perpetuated by the developed video games, then her reputation among peers and respect from the district science supervisor could be compromised. In this situation, Mrs. Johnson imposed her authority to lead students to select topics appropriate and relevant to evolutionary biology and ensured video game development erred on the side of educational, discouraging video game mechanics appropriated for fun alone (e.g., "collecting" DNA points or using portals to transmit species to topographical regions where challenges could be resolved). The three games to emerge from the workshops, Down the Rabbit Hole 1 & 2, which explored DNA mutations and how they help a species develop the ability for camouflage to increase species fitness, Apocalypse, which explored the survival of members of a species most fit along with mate selection based on genetic variation to strengthen the species over time, and The Chita-Tánga, which explored migration to necessitate adaptation while increasing the ability of members of the species to survive and reproduce, all resulted in what can be classified as serious games (Honey & Hilton, 2011), where the perceived educational value of the end-product far exceeded the fun factor. Nevertheless, whether students had intended to develop serious games is an issue to be explored further. In these workshops, that decision was made by the teacher and was used as

a prerequisite for continued participation in the sessions. Had the students been granted more leeway, the number of fun games may have exceeded the serious.

Discussion

The approach used in the two case study vignettes has been used previously in research that has highlighted the importance of micro-politics in formal educational settings, (Ball, 1987; Blase, 2005); for instance, showing the subtle strategies employed by teachers to resist forms of administrative control (Apple, 1986). Along similar lines, the two accounts illustrate how complex political motives and beliefs underlie teachers' willingness and ability to "orchestrate" a TEL activity. In the first example, by suspending the existing power relations that shape curricula, assessment regimes, timetabling and what can be considered as acceptable knowledge, technology provides a context and a pretext to actively resist the pressing requirements and expectations of a formal school environment. In this temporary space that exists between borders (see Giroux, 1992) the teacher takes "matters into his own hands" and creates a dialogic interaction with his students that reflects his own personal beliefs and political views. Conversely – and almost as a counterpoint to the first case study – the second example shows an exercise of authority in the service of consensus, whereby the orchestration of the TEL activity along conservative lines reveals the underlying assumptions about the role of institutional settings in determining what constitutes legitimate knowledge. The teacher's decision to support such consensus is therefore a clearly political act meant to reassert a standing within an established social order, to avoid repercussions in terms of reputation that might compromise chances of career progression and development.

To further add to the interpretation suggested here we draw upon the notion of socially shaped technology (Bijker, 1995). Following this theoretical perspective it could be

contended that technologies, and digital technologies in particular, have acquired strong symbolic qualities stemming from their relationships with different cultural domains: media production cultures, out-of-school cultures, corporate cultures and so on (see Buckingham, 2007). These qualities could be said to contribute to a disruption of the regular flow of instruction, thus requiring from educators, as well as students, a series of readjustments that cannot be explained as driven only by a desire for increased potency and efficiency of learning. Rather, technology often acts as a "wedge" pushed between the normality of daily teaching and learning and the underlying tensions and dynamics in a local context, thus bringing into relief the micro-political agendas that can help us understand why TEL activities take certain shapes instead of others. The case study vignettes above begin to reveal this non-rational nature of technology diffusion and adoption.

As a final caveat to the discussion ensued from the case study vignettes, we would like to acknowledge that our take on orchestration could certainly benefit from a more systematic analysis of the many processes and structures involved in the relationship between power and the enactment of TEL activities. In this paper we tentatively focused on two specific elements: resistance and exercise of authority in the service of consensus. We hope that future research efforts might also account for other important aspects (see also Blase, 2005): conflict resolution, influence, vision development, leadership and so forth. Another productive line of inquiry, and one additionally neglected in this paper, is the study of how other actors and "stakeholders" - students and parents in the first place - negotiate or resist attempts to introduce technology in the normal flow or schooling (see Hope, 2005).

Concluding remarks

In this article, we proposed that the current academic views about "orchestrating TEL environments" are characterised by an undue and constraining emphasis on instructional

design, while this notion could be used just as productively to widen the scope of the theoretical discussion. While we are not dismissing the development of a novel paradigm to investigate and develop instructional techniques that may support educators to manage complex, technology-enhanced learning environments - e.g. "usability at the classroom level" (Dillenbourg et al. 2011b) - we would like to argue that the true potential of orchestration is as a heuristic device to analyse different facets of teacher professionalism against dimensions like empowerment and emancipation. In this alternative type of inquiry, orchestration would help to explore the tensions and the negotiations that always accompany educational practice, and conversely it would help to reflect on personally held assumptions, as TEL researchers, around the relationship between power, teachers' professionalism and technology diffusion, adoption, and use.

Our main contention is that orchestration should be seen against the complex systemic backdrop of existing relations and tensions in an education system. As such, the "ecological" perspective in education can provide useful theoretical resources for a more informed and satisfactory academic debate. However, we would also like to argue for a re-discovery of the "warnings" that were formulated when notions derived from systems theory and ecology started to gain traction in educational research (e.g. Lemke 1997). These warnings are powerfully captured in Valerie Walkerdine's point that we should not neglect the study of how meanings are actually made in such systems (Walkerdine, 1997), focusing for instance on how subjects and subjectivities are constructed in these ecologies as persons rather than, as Lemke suggests by effectively capturing Walkerdine's view, "mysterious melding of bodies and minds. (Walkerdine) wants to know how contexts are made, how they are determined and not leave them as unproblematically given environments" (Lemke, 1997 p.41).

In short, if we seek to help teachers cope with the complexities of TEL, then emphasis on the rational choices of instructional design alone may be insufficient, the existing political and cultural dynamics of actual power in schools deserving equal attention. In this respect, orchestration may be an opportunity to problematise the relationship among teachers, technology, students, and the different agendas and institutional pressures operating simultaneously. This goes beyond a simple acknowledgement of the constraints, and the related suggestion made by Dillenbourg that these should be embedded in the design process. Paraphrasing Bauman (1991), there are "disordered" aspects in social contexts that simply cannot be contained or embedded in any ordering design, but are to a significant extent endemic and inevitable. A "technology-enhanced classroom" is a very complex social context and is no exception to this rule. In fact, drawing on the ideas of Henri Lefebvre about spatial planning as a design-based approach, we would like to contend that a classroom is never a neutral, objective space, which can be acted upon using the techniques and the tools of design and the language of technology (Lefebvre, 1991). This approach would place undue emphasis on the form of education whilst ignoring its contents, what populates the form: the individuals in the first place. Therefore, any discussion about the power of teachers in schools cannot ignore the politics involved, and like the discussion on the politics of space advocated by Lefebvre (2009):

> "It would not simply proceed by enumerating the constraints; it would attempt to unite the appropriation of time and space by the users, the individuals, and the groups... taking into account the complexification of society: the fact that society is becoming increasingly complex and diverse (...) if one engages in the study of what populates the form, if the focus is on the contents and not on the pure form, then we can see how people often actively resist attempts to be inserted into the form" (p. 169).

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