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Classroom orchestration: Synthesis

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A B S T R A C T

Orchestration is an approach to Technology Enhanced Learning that emphasizes attention to the challenges of classroom use of technology, with a particular focus on supporting teachers' roles. The present collection of papers on orchestration highlights broad agreement that classrooms are variable and complex and that teachers have an important role in adapting materials for use in their own classrooms. The synthesis also shows a difference of opinions in how useful "orchestration" is as a metaphor, the proper scope of issues to include when studying orchestration, and how to approach design. Despite the lack of consensus, orchestration is a timely and important shift of focus and all of the approaches merit further exploration. The field shows healthy self-criticism and debate, which is the hallmark of fields with the potential for great progress.

1. Introduction

This collection of papers reflects a vivid discussion in the Technology Enhanced Learning (TEL) community. The discussion is rooted within the framework of the Stellar European Network of Excellence, which considered orchestration of learning as one of the three grand challenges of the field (Stellar, 2010). The discussion has also spread more broadly to Computer Support Collaborative Learning (CSCL) research outside of Europe.

At its core, the discussion reflects a rethinking of the relationship between research and practice. As Chan (2013) describes it, this rethinking goes from a "laboratory" view to a "field" view. In the former view, technology is developed in the lab in idealized settings, and then transferred to the classroom, to settings of practice. The laboratory view makes it easy to do scientific research, but hard to deliver impact.

In the latter view, problems of practice are highlighted. Classrooms are complex and highly variable; they are unpredictable; the most critical resource is time. This view explains why teachers fail to adopt many research-based learning technologies – such technologies too often either add too much complexity, fail to be flexible enough in the unpredictable world of the classroom, or simply take too much time. This view privileges the process of adoption and adaptation – teachers choosing to make a new tool their own and making it fit the circumstances of their classrooms. As Dimitriadis, Prieto and Asensio-Pérez (2013) say, teachers "adopt and integrate" materials.

Nussbaum and Díaz (2013) provide a visceral example of the pain new technologies can inflict on practitioners: we suspect many researchers will empathize with the difficulties of transitioning between versions of Microsoft Word and will remember just how unwelcome the "improved" version was. By analogy, teachers may not agree with researchers on what constitutes an improvement. Sharples (2013) states another dimension of the dilemma clearly: the problem of overly complex tools may not be solved by adding yet more complex tools on top – as this may make the complexity and time demands of technology even worse. Sharples worries "orchestration" too will fail if the first layer of complexity merely begets another layer in the name of "making things simpler".

This effort to bring the dilemmas of practice into focus reflects a maturation of the field. Many members want to move beyond doing good science that merely promises later application; instead many innovators in TEL or CSCL now find educational needs (and not just related scientific problems) to be truly motivating and want to create materials and tools with impacts that can be realized in their lifetimes in practical educational settings at scale.

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Thus "orchestration" signals a desire to rethink how researchers do their work so as to increase the potential to make a difference in educational settings. "Orchestration" is therefore more than an analysis of why adoption of research-based technologies has been frustratingly slow, but also an effort to do more meaningful research by acknowledging the complexity and variability of classrooms and the mediating role of the teacher in everything that happens inside classrooms. Indeed, all responses to Dillenbourg (2013) in this collection appear to agree on at least two points. First, they agree that classrooms are complex – filled with multiple purposes, agents, resources, and activities. Second, they agree that the agency of the teacher is of particular importance. All the contributors show respect for the role of teachers in deciding what does or does not get implemented in classrooms. In addition, the contributors respect teachers' perceptions of the difficulties of using new technologies relative to the potential benefits. Further, the common perspective acknowledges that teachers have a role in adapting materials for classroom use.

2. A field in transition

As befits a field in transition, there is little agreement on anything else. Let's begin with the metaphor itself. Although Dillenbourg was an instigator who drew attention to orchestration as a metaphor, he now suggests the metaphoric use is more trouble than its worth. In its place he offers a working definition that is fairly narrow and specific: "Orchestration refers to how a teacher manages, in real time, multi-layered activities in a multi-constraints context" Several other authors offer definitional phrases. Chan suggests a narrower definition of orchestration as "The methods and strategies empowered by a technology equipped classroom that an educator may adopt carefully to engage students in activities conducive to student success and learning." Prieto, Holenko-Dlab, Abdulwahed, Gutiérrez, and Balid (2011) use a more comprehensive, non-normative definition as "The process by which teachers and other actors design, manage, adapt and assess learning activities, aligning the scaffolding at their disposal to achieve the maximum learning effect, informed by theory while complying pragmatically with the contextual constraints of the setting". Such a definition relies on the "5 + 3" framework, shown in Fig. 1, which has been recently validated by an international panel of experts. Yet others maintain the metaphor is useful. Most specifically, Kollar and Fisher (2013) find it helpful as defining a design continuum that starts closer to a pure theory-driven concept but becomes more practice-oriented through layers of elaboration.

The disagreements go far beyond the metaphor. Perrotta and Evans (2013) critique the emphasis on computing entirely, suggesting that real orchestration should start with human dilemmas of power which transcend specific tools and materials. Dimitriadis and colleagues likewise warn that the focus on classrooms may be too narrow. Sharples notes that students may be part of the "orchestration" solution, too, in addition to teachers. Overall, once human agency in complex social settings is opened for inquiry, it's not so easy to put the cat back in the bag. Orchestration may have begun as a focus on developing better technologies for classrooms, but it seems unlikely to end there. Indeed, a related perspective emerging from a non-technology focus is "design research for implementation" – see Penuel, Fishman, Cheng, & Sabelli, 2011. This focus opens up huge bodies of literature in "diffusion of innovation" and participatory design that may now be more relevant to TEL and CSCL (e.g. Muller, 2009; Rogers, 2003), as may be bodies of evaluation work related to how innovations result in school change (e.g. Fullan, 2005).

There is also little agreement on the overall approach to orchestration that should be taken. Dillenbourg advocates stepping back from complexity, toward minimalism in his "modest computing." Nussbaum and Díaz appear to instead opt for detailed specification of how technology should be implemented by teachers; his orchestration is close to detailed curriculum design or lesson planning. Sharples emphasizes formative assessment – that orchestration should provide teachers with data they can readily interpret to make instructional decisions, and configurable options that teachers can choose in order to translate their decisions into actions. Looi, however, takes a more holistic approach – seeing orchestration in the fit between a flexible tool (GroupScribbles) and a set of pedagogical commitments ("progressive inquiry").

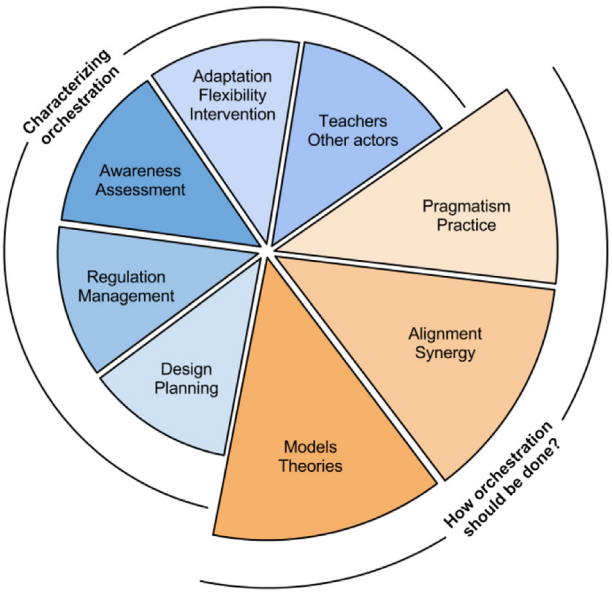

Fig. 1. The "5 + 3" framework that depicts the current discourse on classroom orchestration.

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Others, however, emphasize a broader continuum of design. For example, Tchounikine (2013) allows for different kinds of tools and affordances for making decisions in real time than for making decisions in more relaxed "analysis and planning" time. The Tchounikine version anticipates a systems engineering approach to orchestration in which the engineer helps rationalize technology use by crafting good boundaries and interfaces that "fit" the realities of researcher's innovation context and teacher's practice context. Koller and Fisher add the possibility of a non-teacher designer who makes anticipatory decisions, subject to later modification or elaboration by teachers. Finally, another view of the "5 + 3" framework (Prieto, Dimitriadis, Villagrá-Sobrino, Jorrín-Abellán, & Martínez-Monés, 2011) allows for a great richness of orchestration research including questions of: what is orchestration (processes, interventions, or coordination)? Who is involved in orchestrating? What is orchestrated? How is it done? When does it happen? What kinds of environments does it address? And finally, what teaching and learning processes does it effect?

3. Successful orchestration

On a hopeful note, several papers give examples of apparent orchestration success. Looi and Song (2013) describe how their research identified a fit between GroupScribbles and teacher's agency within their "progressive inquiry" pedagogical approach. Balaam (2013) describes the "Subtle Stone" as a very simple way to create more ambient awareness of emotional states. Nussbaum alludes to his successes in delivering CSCL at scale in several South American countries. Another early example worth mentioning is NIMIS (Hoppe et al., 2000), which aimed at supporting and integrating learning processes in a primary school classroom using ubiquitous computing technologies such as pen-based tablets in the learners' places and a central interactive board. The NIMIS classroom featured a mix of modest and heavier computing elements. Group work, especially work in pairs using one tablet, was supported by implicit design principles such as multiple login in one place and interaction with a "learning companion". One of the most important design principles was "not to let technology get in the way."

When discussing orchestration from the point of view of CSCL, the role of computation, be it "modest" or heavy-weight, is a legitimate and distinctive concern. Dillenbourg shows how *classroom augmentation* can be achieved with modest technologies. The question, however, is if a modest computing approach misses further value-adding opportunities, e.g. based on the analysis of learning traces and/or massive storage and sharing of learner-generated artifacts. This leads to extending the classroom setting with *monitoring and supervision tools* to support real-time classroom management, as exemplified in Looi's scenario. However, here Sharples' caveat has to be taken seriously: explicit "orchestration technology" may introduce new and unnecessary complications. To counter these risks, graphical representations and interaction logics (for supervision tasks) have to be carefully designed. Also the option of postponing the usage of monitoring and analysis results to post-classroom situations (e.g. as reflection support for teachers) should be considered.

Model-based configuration and preparation of learning environments, characterized by Tchounikine as "primo-scripting", is close to the notion of orchestration in Software Engineering and Business Process Modeling. In both fields, "orchestration" is related to the configuration and setting-up of a run-time environment based on a priori models or specifications. In our field, this notion has a well-defined equivalent: The configuration of a run-time learning environment in terms of tools, resources and possibly scaffolds based on a given learning/teaching process model or learning design (e.g. using IMS-LD). This notion of orchestration is more or less consistent with the musical metaphor and it ties in with research on CSCL scripting (see Kollar and Fischer). It also resonates with ideas from core fields of pedagogy: Oser and Baeriswyl (2001) have taken up the concept of "choreography" as a bridge between instructional design and actual classroom management. From a computational point of view, the metaphor of "choreography" raises the question whether or not symbolic and graphical notations used for describing and modeling learning processes can actually be used for real-time steering of a classroom. Niramitranon, Sharples, Greenhalgh, and Lin (2007) have proposed a unified approach that combines both aspects. It uses an intuitive tabular representation for classroom procedures that comes close to representations used by teachers in their lesson planning. This is a promising example of bridging over from primo-scripting to classroom management.

4. Conclusion

Despite the lack of consensus in the field, we conclude on a hopeful note. First, the shift to balance attention between more idealistic research and realistic problems of practice is a timely and important move toward research in Pasteur's quadrant (Stokes, 1997) – research both with theoretical grounding and practical importance. Orchestration makes sense within a movement in the field to emphasize adoption, scale and sustainability more – to shift from pure invention to a "diffusion of innovation" perspective. Second, the directions being explored – minimalism, specification, and formative assessment, as well as the more elaborate systems engineering perspectives – are all deserving of more inquiry and there is no apparent reason why the eventual solutions would not combine several of these. Third, the field shows ample evidence of healthy self-criticism and debate that is the hallmark of fields with the potential for great progress. All in all, researchers from a range of TEL and CSCL fields have much to gain by joining in the debate and seeking ways to design learning tools so that they are theoretically motivated, practically useable and useful, and designed for the realistic classroom contingencies that require flexible adaptations by teachers.

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References

Balaam, M. (2013). A response from M. Balaam. *Computers & Education*. ISSN: 0360-1315. Available online 23 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.009. http://www.sciencedirect.com/science/article/pii/S0360131513001024.

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Chan, T.-W. (2013). Sharing sentiment and wearing a pair of 'field spectacles' to view classroom orchestration. *Computers & Education*. ISSN: 0360-1315. Available online 20 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.011. http://www.sciencedirect.com/science/article/pii/S0360131513001048.

Dillenbourg, P. (2013). Design for classroom orchestration. *Computers & Education*. ISSN: 0360-1315. Available online 27 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.013. http://www.sciencedirect.com/science/article/pii/S0360131513001061.

Dimitriadis, Y., Prieto, L. P., & Asensio-Pérez, J. I. (2013). The role of design and enactment patterns in orchestration: helping to integrate technology in blended classroom ecosystems. *Computers & Education*. ISSN: 0360-1315. Available online 22 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.004. http://www.sciencedirect.com/science/article/pii/S0360131513000973.

Fullan, M. (2005). The meaning of educational change: a quarter of a century of learning. In A. Lieberman (Ed.), *The roots of educational change* (pp. 202–216). London: Springer.

Hoppe, H. U., Lingnau, A., Machado, I., Paiva, A., Rui Prada, R., & Tewissen, F. (2000). Supporting collaborative activities in computer integrated classrooms – the NIMIS approach. In *Proceedings of the 6th international workshop on groupware (CRIWG 2000), Madeira, Portugal, Oct. 18–20, 2000* (pp. 94–101). IEEE Press.

Kollar, I., & Fischer, F. (2013). Orchestration is nothing without conducting – but arranging ties the two together! A response to Dillenbourg. *Computers & Education*. ISSN: 0360-1315. Available online 23 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.008. http://www.sciencedirect.com/science/article/pii/S0360131513001012.

Looi, C.-K., & Song, Y. (2013). Orchestration in a networked classroom: where the teacher's real-time enactment matters. *Computers & Education*. ISSN: 0360-1315. Available online 18 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.005. http://www.sciencedirect.com/science/article/pii/S0360131513000985.

Muller, M. J. (2009). Participatory design: the third space in HCI. *Journal of Human-computer Interaction: Development Process*, 165–197.

Niramitranon, J., Sharples, M., Greenhalgh, C., & Lin, C.-P. (2007). SceDer and COML: toolsets for learning design and facilitation in one-to-one technology classroom. In *Proceedings of the international conference on computer in education (ICCE 2007). Nov. 5–9, 2007* (pp. 385–391). Hiroshima/Amsterdam: IOS Press.

Nussbaum, M., & Diaz, A. (2013). Classroom logistics: integrating digital and non-digital resources. *Computers & Education*. ISSN: 0360-1315. Available online 17 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.012. http://www.sciencedirect.com/science/article/pii/S036013151300105X.

Oser, F. K., & Baeriswyl, F. J. (2001). Choreographies of teaching: bridging instruction to learning. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed.). (pp. 1031–1065) Washington DC: American Educational Research Association.

Penuel, W. R., Fishman, B. J., Cheng, B. H., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher, 40*(7), 331–337.

Perrotta, C., & Evans, M. A. (2013). Orchestration, power, and educational technology: a response to Dillenbourg. *Computers & Education*. ISSN: 0360-1315. Available online 20 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.007. http://www.sciencedirect.com/science/article/pii/S0360131513001000.

Prieto, L. P., Dimitriadis, Y., Villagrá-Sobrino, S., Jorrín-Abellán, I. M., & Martínez-Monés, A. (2011). Orchestrating CSCL in primary classrooms: one vision of orchestration and the role of routines. In *Proceedings of the 9th international conference on Computer-Supported Collaborative Learning (CSCL 2011), July 2011, Hong-Kong, China*Paper Presented at the Workshop "How to Integrate CSCL in Classroom Life: Orchestration". Available online at http://www.gsic.uva.es/~lprisan/CSCL2011_WSOrchestration_Prieto_submission.pdf.

Prieto, L. P., Holenko-Dlab, M., Abdulwahed, M., Gutiérrez, I., & Balid, W. (2011). Orchestrating technology enhanced learning: a literature review and a conceptual framework. *International Journal of Technology-enhanced Learning (IJTEL), 3*(6), 583–598.

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Sharples, M. (2013). Shared orchestration within and beyond the classroom. *Computers & Education*. ISSN: 0360-1315. Available online 18 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.014. http://www.sciencedirect.com/science/article/pii/S0360131513001073.

STELLAR Network of Excellence. (2010). *Orchestrating learning*. Stellar website. http://www.stellarnet.eu/d/1/1/Orchestrating_learning.

Stokes, D. (1997). *Pasteur's quadrant: Basic science and technological innovation*. Washington DC: Brookings Institution.

Tchounikine, P. (2013). Clarifying design for orchestration: orchestration and orchestrable technology, scripting and conducting. *Computers & Education*. ISSN: 0360-1315. Available online 20 April 2013. http://dx.doi.org/10.1016/j.compedu.2013.04.006. http://www.sciencedirect.com/science/article/pii/S0360131513000997.

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