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Shared Orchestration Within and Beyond the Classroom

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The TEL research community has long neglected the dynamics of the real school classroom. Forty years ago TEL (or Computer Assisted Instruction as it was then) held out a promise of making life easier for teachers, while also enhancing the effectiveness of student learning.

> *For so long teaching has been regarded as a human task that it is novel to suggest that a machine should take over the role of contact with the students, and leave a teacher to do the planning and preparation of the lesson. But it does seem to work, and in a world that is short of teachers there is every reason to develop it as far as possible.* (Dodd, Sime & Kay, 1968)

TEL has never delivered on this promise. Machines have not successfully engaged in teaching students (with a few notable, but limited exceptions). Instead, the modern classroom has become a more complex and demanding place, with the teacher not only having to prepare lesson plans, accommodate formal curricula, and follow regulations on health, safety and discipline, but also understand and manage a variety of technologies such as interactive whiteboards, desktop and laptop computers. Into this volatile mix we are now proposing to add orchestration technology.

The new promise to teachers is similar to that of 1980s expert control systems: You have to operate an increasingly complex dynamic system involving interacting people and technologies, so we'll add another layer of technology that will enhance learning while helping you to manage and interpret the system. The classroom becomes like the stock market dealing floor, or the nuclear power plant control room.

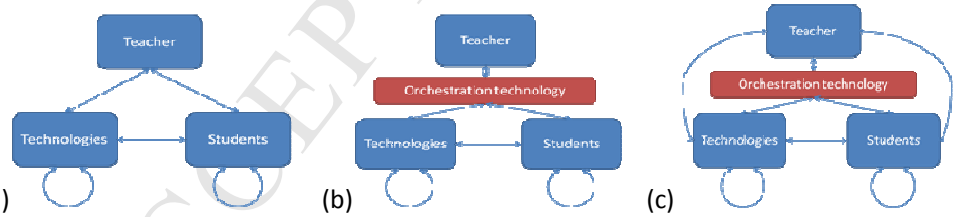

Figure 1. Dynamics of the technology-enhanced classroom

The modern classroom has a teacher managing interactions of students and technologies (Figure 1a). We add orchestration technology (Figure 1b) to support the teacher in "monitoring the situation, deciding what adaptations are necessary and then performing these adaptations" (Dillenbourg, 2013). The intention is to achieve "educational regulation" (*ibid*.) in the open, continually changing system of a technology-equipped classroom – a kind of fly-by-wire for the teacher. The reality is that teachers will not only have to learn and manage a new form of technology (for lesson design and real time classroom management), but will still have to interact directly with the students and their technologies, (Figure 1c).

An example might help here, taken from an actual school lesson. The teacher and students were using an early version of our nQuire technology for inquiry science learning. The teacher was at the front of the class and each student had a netbook computer running nQuire (Mulholland, et al. 2011). The teacher was managing a lesson where the students were sharing and analysing field data. All she could see were rows of laptop lids, with no knowledge of what the children had on their computer screens, and she was struggling to keep the children in order and working on the same task. So, one approach would be to add an orchestration system that allows the teacher to sit at a console where she could switch to any student's screen or take control of the students' computers, to orchestrate the lesson. But as well as communicating directly with the children, and enacting the lesson, she then has to view and manage their computers. A simpler solution would be to have a button she could push to 'freeze' all the computer screens and get the children's attention. An even simpler solution (which is what she used) would be to tell them to close the lids when she was talking – but they then had to power up the computers after each time she intervened.

The point of this anecdote is that, as Dillenbourg indicates, we have to confront the reality of the classroom and the demands on the teacher. We also need to understand the many ancillary activities, such as coping with classroom disruptions and managing complex technologies. We need to find a way to deliver on the promise of enhancing learning while reducing (or not greatly increasing) the demands on the teacher. How can we do this?

Let us consider Dillenbourg's broader set of constraints.

Assessment must be part of orchestration. We need to build on imaginative forms of assessing collaborative and constructivist activities, such as peer and group assessment, formalising these as design patterns for classroom management (Villasclaras-Fernández et al, 2009). The EDUINNOVA approach to small group mutual assessment is a good one, where the children first solve a problem individually, then have to reach a group consensus solution, which they then present to the class, with the individual and group outcomes being recorded and stored for assessment (Zurita & Nussbaum, 2004).

It is unrealistic to suggest that design for orchestration will reduce time. I have seen no evidence that adding the orchestration layer will save classroom time. Instead, I suggest we need to look for ways of increasing the time on task, by expanding the learning beyond the 50 minute lesson.

Discipline is important. Unless the teacher has some control over the class, then there's no chance of success. But there needs to be student self-discipline, imagination, improvisation, as well as teacher-imposed control.

Energy management is essential. Teachers do not have surplus energy to spend on designing scenarios and providing additional forms of feedback.

The classroom also has to be compatible with activities that are performed in that classroom, but the learning does not have to be bounded by the classroom walls.

One way to deliver on the promise to teachers while designing for orchestration would be to simplify some component of the complex system: easier to use technology, a simpler lesson plan, or a simplified task. We need to take Occam's Razor seriously, and not multiply entities beyond necessity. That means we should not impose a layer of orchestration technology unless it really can either

simplify the task of classroom management without worsening the learning, or can substantially enhance the learning without imposing huge demands on the teacher.

Or we can remove the orchestration technology layer entirely and just use 'orchestration' to describe designs for real time management of innovative classroom activities, which Tchounikine calls 'primo-scripting'. Then, as learning technologists we have to engage with the teacher's world of lesson planning and classroom management, for example offering advice on innovative lessons with interactive whiteboards, or showing how lesson plans can incorporate new devices such as smartphones as tools for innovative teaching, with all the difficulties this entails.

A third, more disruptive, approach is to share responsibility for orchestration between the teacher the students and the technology. This is the one we have adopted for nQuire. In this form of orchestration, the teacher and all the students have similar computer toolkits designed to guide the students through a productive learning activity (for nQuire, an inquiry learning cycle), by means of an Activity Guide, rather like a 'dynamic lesson plan'. Normally, the teacher will select a pre-prepared Activity Guide and this can be modified in advance or on-the-fly by either the teacher or the students (for example, in nQuire the entire class or collaboration groups can alter the inquiry questions, decide on the method of investigation, select measures, change the visualisation). The Activity Guide is not a 'learning environment' with a few parameters to tune, but a guide to conducting open scenarios: recording findings, engaging in debate, creating shared outcomes. The students start the activity in the classroom, guided by the teacher, and then continue it beyond the 50 minute lesson, as homework or an outdoors activity. The responsibility for orchestrating their learning and enacting the activities lies with the students. Back in the classroom, the students share their findings in small groups and then present their conclusions to the class.

The advantage of this approach to orchestration is that the orchestration technology does not try to intercede between the teacher and the students, but instead acts as a personal guide for each teacher and student. Since the Activity Guide runs in a web browser, the scenarios do not need to run on the same devices. As Tchounikine proposes, students and teachers may use whatever tools they find available and convenient. The activities are not constrained to a 50 minute lesson, but can be continued as out of class work. The teacher is empowered to manage the lesson and to modify the Activity Guide.

The drawbacks are that:

- The teacher and the students all need to know how to operate the orchestration technology, though in practice we have found the students manage this with little difficulty.
- The teacher needs to know that the students are continuing to manage their learning beyond the classroom, but that is true for any homework assignment.
- The results need to be coordinated back in the classroom. That is the tough one, and we have found that this coordination lesson does place additional demands on the teacher. If responsibility is given to student groups to integrate and present their findings, then the burden on the teacher is lowered, and she can concentrate on supporting the difficult groups and on drawing conclusions from the findings.

In conclusion, orchestration is a helpful word for TEL. We should not get too hung up on whether it refers to planning or real-time classroom management. As Dillenbourg indicates, we do need to

consider seriously how technology-enhanced orchestration meets the reality of the modern classroom, and how to make the learning more effective not more burdensome.

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