

Teacher Orchestration Load: What Is It and How Can We Lower the Burden?

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Rapid Community Reports Workshop Outcomes

Teacher Orchestration Load: What Is It and How Can We Lower the Burden?

Orchestration load reflects the teachers' attentive processing during classroom orchestration. Designing teacher-supporting tools to lower the burden is a top priority.

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Abstract

This report provides details of a workshop conducted as an online pre-conference event during the ISLS Annual Meeting 2021. The workshop consisted of two main adjoining parts focusing on its two themes: orchestration load and related teacher support tools. The main findings of the workshop showed that (1) a definition of orchestration load requires further elaboration, (2) there are limited ways to measure this notion, and (3) attention should be paid to sharing orchestration load among other actors, e.g., students, intelligent agents, that may facilitate the simplification of activity regulation. Balancing orchestration load among multiple actors may lower the load experienced by the teachers in real-time in authentic educational contexts.

Keywords

Orchestration load, orchestration, learning analytics, teacher support tools

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Overview

Teachers engage in multiple tasks under multiple constraints within their everyday classroom teaching situations. Some of these tasks may include monitoring (individual students or groups); diagnosing (detection of deviations and potential misunderstandings); advising, praising, and criticizing (for positive and negative behaviors of students); applying changes to learning activities on the fly; as well as effectively using available learning technologies. Constraints may emerge from different variables such as time, curriculum, space, and discipline to name a few (Dillenbourg & Jermann, 2010). Conducting multiple tasks under multiple constraints in real time is demanding and requires teachers' effort.

The concept of *classroom orchestration* aims to capture the complexity associated with the real-time management of multiple learning activities within multi-constrained learning environments (Dillenbourg & Jermann, 2010). Within this concept, teachers are metaphorically referred to as *conductors of an orchestra* as they take the leadership to facilitate students' learning in real-time by regulating a broad range of activities at different levels (e.g., individual, group, classroom) (Dillenbourg & Jermann, 2010). However, rapid capturing and real-time processing of classroom information to facilitate the coordination of learning activities and to identify potential problems is challenging as it demands the constant distribution of teachers' attention across different levels (van Leeuwen & Rummel, 2019). *Orchestration load* seeks to capture the attentive load teachers encounter when regulating multiple activities and learning processes in real-time (Prieto et al., 2018). Exploration of how orchestration load emerges in authentic learning situations is important because such an understanding could help decrease the factors that contribute to increasing workloads. Offloading unnecessary workload can help to enhance teachers' well-being.

Existing studies often refer to orchestration load as a black box and little is known about its contributing factors (Amarasinghe et al., 2021a). The lack of established instruments to measure this notion is also seen to prevent studying orchestration load in greater detail. Learning Analytics (LA) constitutes an emerging research area and is defined as the "measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (Siemens & Gašević, 2012). LA draws on a wide range of disciplines, such as machine learning, data mining, information visualization, and psychology. It is expected that teacher support tools that incorporate LA can offload teachers' orchestration actions, and can contribute to lessening the orchestration load. For example, generating visualizations of online interactions using LA may facilitate diagnosing of issues and save time for teachers to monitor students. Generating automatic summaries based on artifacts produced by students using LA may facilitate teachers' debriefing actions. Automatic

analysis of students' profiles using LA to formulate teams based on a criterion defined by the teachers also has the potential to facilitate saving time and energy for practitioners.

Although LA can be beneficial for numerous orchestration actions, evidence on whether such LA-based teacher supporting tools adequately contribute to lessening teachers' orchestration load is lacking (van Leeuwen & Rummel, 2019; Amarasinghe et al., 2021a). For instance, teacher support tools that generate difficult to interpret visualizations, or tools that are less flexible and disregard teachers' activity design decisions may introduce an additional burden instead of simplifying and supporting activity regulation (Sharples, 2013). To this end, investigating orchestration load should involve detailed questioning on how it emerges in authentic learning situations, and how it informs the design of teacher support tools and technologies. Accordingly, the purpose of our workshop was two-fold:

1. We focused on the theoretical and methodological perspectives related to orchestration load and aimed to broaden our understanding of this complex notion. The specific questions addressed were the following:

- What theoretical perspectives are there on orchestration load?
- How can we measure orchestration load? and what kind of activities/facets influence orchestration load?

2. Regarding teacher support tools, we aimed to identify existing teacher-support tools, emergent issues, and opportunities for improvement. The specific question addressed was the following:

- How can we lower the burden of orchestration load using teacher support tools?

Workshop Attendees



The organizing committee of the workshop consisted of 8 researchers (from Spain, Netherlands, Germany, Australia, and the United States) who share a common interest in Computer-Supported Collaborative Learning (CSCL), educational technology, learning analytics (LA), and teacher orchestration. Several members of the organizing committee had previously been involved in co-organizing similar workshops in national and international conferences: Social Network Analysis (CSCL2017), Collaboration Analytics (CSCL 2019), Orchestrating Learning Analytics (CSCL 2018), Open Science in Technology-Enhanced Learning (EC-TEL 2018), The Orchestrated Collaborative Classroom: Designing and Making Sense of Heterogeneous Ecologies of Teaching and Learning Resources (CSCL 2015).

An open invitation to interested participants was circulated via a public website. The intended audience included researchers interested in topics related to classroom orchestration and learning analytics. Interested participants were asked to submit their inputs before the workshop regarding (1) perspectives related to the notion of orchestration load, and (2) previous experience in research and/or practice with tools or methods for lowering orchestration load. Preparatory inputs collected from the participants were used during the online workshop activities.

The online workshop brought together 18 attendees including senior researchers (who are also university instructors and shared their teaching perspectives during the workshop), junior researchers, and one representative of a research funding organization (see Appendix). The geographical distribution included Europe (Spain, Switzerland, Germany), the United States, and Israel. They had a similar research focus and had common interests in research areas such as CSCL, human-centered design, and teacher support tools. Some attendees had previous expertise and have made scientific contributions in specific research areas such as orchestration of collaborative learning scenarios.

Workshop Structure



A half-day online workshop was conducted on June 2, 2021. The workshop had two main adjoining parts (see Figure 1), focusing on its two themes.

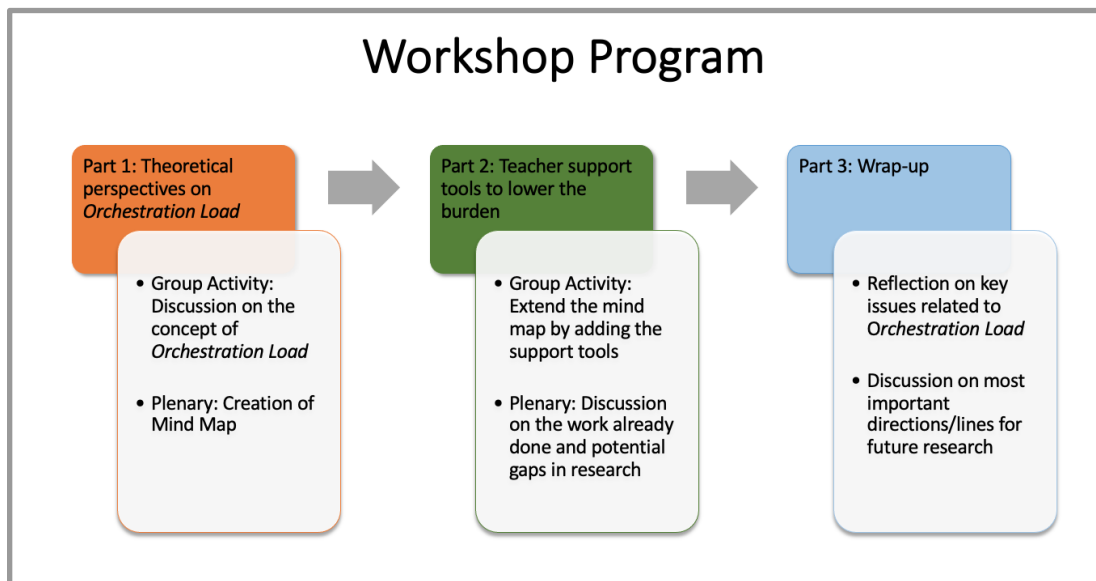


Figure 1: Workshop activities

The first part focused on the theoretical perspectives on orchestration load. Attendees worked in groups and collaboratively constructed a mind map to organize the important ideas related to orchestration load (see Figure 2). Attendees pointed out that the existing studies do not sufficiently distinguish different facets of orchestration load and there is a lack of understanding on different contributing factors, e.g., teachers' previous experiences, expertise/competencies, and task at hand. It was seen there is a need to develop new approaches to estimate the load in a more nuanced way. The need to shift existing research foci towards a shared orchestration load where the load is distributed among other stakeholders (e.g., students, conversational agents), was seen as essential among the researchers.

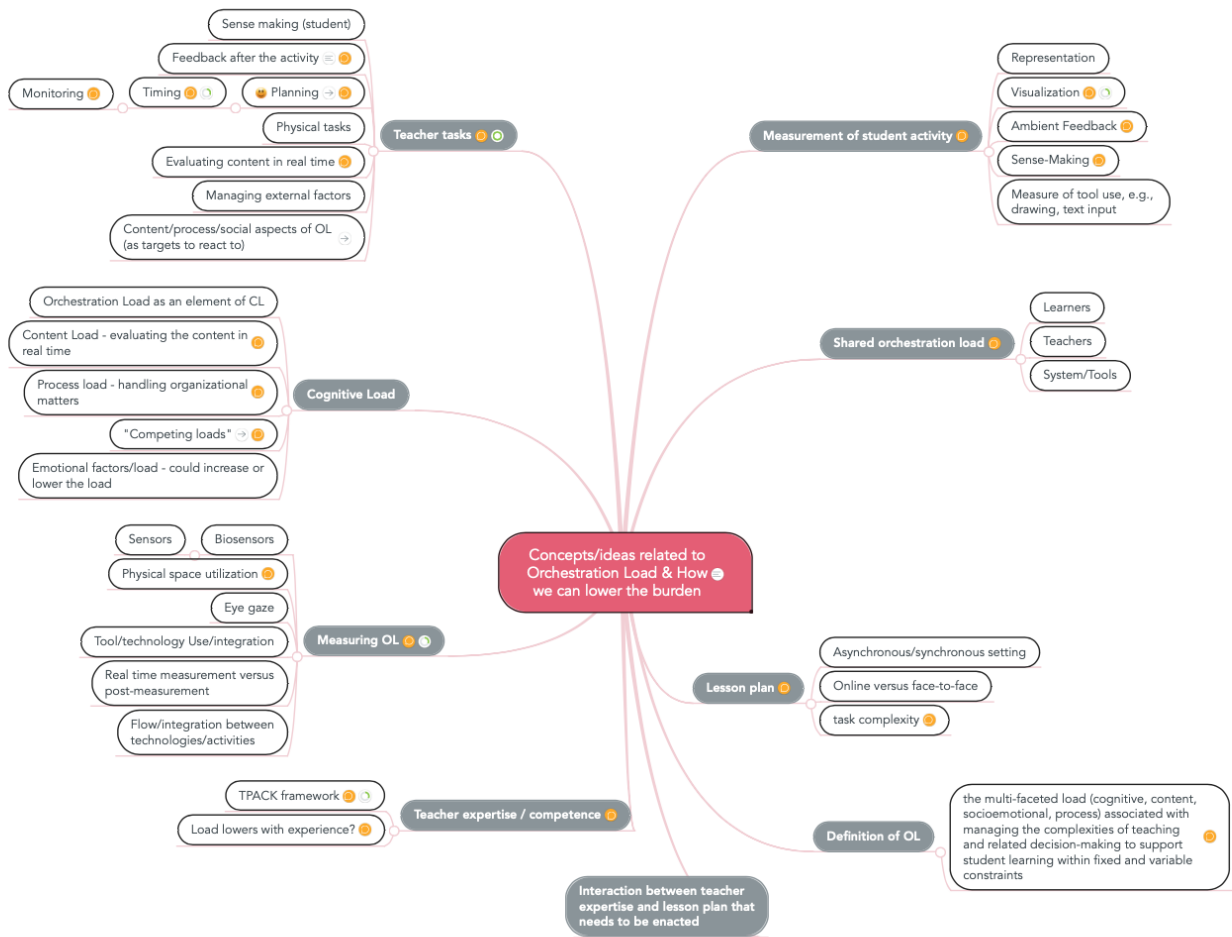


Figure 2: Mind map generated during the workshop in June 2021 (also available online at: <https://tinyurl.com/868crf9a>)

In the second part, attendees extended the mind map by indicating for which elements of orchestration load there are existing teacher support tools. This activity aimed to identify which areas of orchestration load have already been targeted with support tools and which have not, to identify potential research gaps. Different teacher support tools proposed by attendees were broadly categorized into three groups by the workshop organizers: (1) preparation tools that aim to support customizing learning designs during the activity design stage; (2) real-time tools that allow orchestration actions, e.g., group formation; (3) post-reflection tools that support data-informed reflection on learning designs. Apart from the aforementioned tools attendees also proposed other non-technical ways to reduce orchestration load, e.g., recruiting teaching assistants to support teachers in managing classroom activities in real-time.

Within this session, several overarching points also caught the participants' attention. For instance, exploring and understanding which tasks/loads are beyond a teacher's capabilities is essential when developing teacher support tools. Designing technologies that support the teacher by supporting other actors, e.g., students, requires further research. Moreover, a majority of the teacher support tools were seen to focus on real-time teacher tasks. This raises the question of whether the bulk of load happens in real-time as compared to design time and calls for research on post-reflection tools and their impact on the design.

Key Issues



Workshop activities led participants to reflect on and discuss three key issues (1) the definition of orchestration load, (2) the desirable level of orchestration load, and (3) measuring orchestration load.

How to define orchestration load?

Existing studies refer to orchestration load as a high-level concept without disentangling its multi-faceted elements due to its complex nature (Prieto, et al., 2018). For instance, different orchestration actions that can contribute to teachers' orchestration load in a classroom include making decisions about student groupings and follow-up activities, monitoring and adjusting current activities. The question is whether such time investments are beneficial for student learning or whether they are detrimental. For instance, If the time spent on student grouping leads to more balanced groups and thereby to more successful collaboration, one could say that the orchestration load is not detrimental but beneficial for student learning.

From a pedagogical perspective, orchestration actions that contribute to enhancing students' learning need to be maximized. However, a lack of understanding of how different factors contribute to an increase or a decrease of orchestration load creates a barrier to understanding and validating how the load is maximized or minimized. Rethinking and redefining the notion of orchestration load (Amarasinghe et al., 2021a) to be inclusive of the different orchestration actions that can contribute to teachers' orchestration load in a classroom could help.

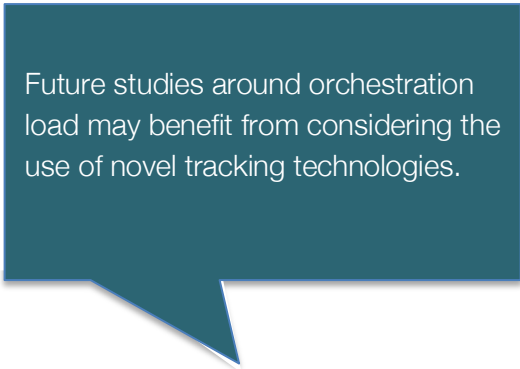
What is the desirable level of teaching support and ensuing orchestration load?

Tools and technologies that support orchestration have been articulated using metaphors such as "teacher cockpits" and "dashboards." The objective of such technologies is to augment the decision-making processes of teachers by providing them access to the required information

(Dillenbourg & Jermann, 2010). However, technologies that disregard the notion of orchestration load may introduce an overwhelming layer of complexity that requires action to be taken in real-time (Prieto et al., 2018). On the other hand, a high level of automatic support (referred to as “autopilot mode”) might also be counter-productive to the autonomy and responsibility of teacher decisions. Workshop participants stressed the need to move towards approaches such as human-centered design, which will facilitate the incorporation of key stakeholders, e.g., teachers, in the design and implementation of orchestration technologies (Dimitriadis et al., 2021). Such participatory approaches include capturing and incorporating teachers’ input for the design, ultimately resulting in better design decisions and useful supporting tools that may maintain desirable levels of orchestration load. Such studies will ultimately shed light on the desirable levels of orchestration load teachers are willing to accept in real-time.

How to measure orchestration load?

The lack of robust instruments available to measure orchestration load emerged as a key issue during the workshop. Although some studies proposed the use of questionnaires to evaluate orchestration load, such an approach is not reliable as it depends on the memory of the event and also asking teachers to answer a questionnaire several times throughout a learning activity to



Future studies around orchestration load may benefit from considering the use of novel tracking technologies.

measure how orchestration load changes over time can disrupt the activity. Future studies around orchestration load may benefit from considering the use of novel tracking technologies. In the following, we provide details about two related studies among several existing studies. For instance, Prieto et al. (2018) proposed a mixed-method approach to measure orchestration load considering self-perception measures (questionnaires) and eye-tracking technologies that reflects the changes in cognitive load (based on pupil diameter mean, pupil

diameter standard deviation, average saccade speed, and number of fixations > 500 ms). Amarasinghe et al., (2021b) proposed the triangulation of self-perception measures (questionnaires) and Electrodermal Activity (EDA) (also known as galvanic skin response - GSR) to assess affective states under different supporting provisions to better understand teachers’ orchestration load. The presence of peaks in EDA signals was seen to imply a change in the affective state of the teachers. Whether such peaks correlated to the stressful moments that contribute to orchestration load has been analyzed using mixed methods. How to incorporate such non-invasive tracking technologies in a way that does not disturb teachers in their orchestration actions and ethical implications in its applicability to real learning situations requires further investigation.

Recommendations for Future Work



The conclusions derived from the workshop activities suggested interesting lines for further research and implications for practice as outlined below.

Sharing orchestration load. Conducting different teacher-centric actions, i.e., monitoring and regulating learning actions at different levels and using different teacher support tools effectively, is demanding and can contribute to an increased orchestration load. However, such attentive processing by teachers is essential to achieving fruitful learning. Orchestration load should not only be seen in a negative sense but rather should be appreciated positively as this load is essential to creating fruitful learning situations that can support achieving the intended learning goals. Different teacher support tools can be designed to facilitate the distribution of orchestration load across different actors rather than putting the entire workload on the teachers hence facilitating to reduce the burden of orchestration. For instance, machine-oriented Learning Analytics (LA) interventions, e.g., pedagogical and conversational agents, can support peer interactions and be beneficial for learning. In complex scenarios such as Computer-Supported Collaborative Learning (CSCL), students can be encouraged to regulate group activities themselves hence sharing the burden of group management (Sharples, 2013). Understanding orchestration challenges associated with different learning situations at different scales and framing a design space that incorporates well-balanced human and machine-oriented LA interventions to share orchestration load requires significant further exploration. Understanding how to amplify the actionability of LA interventions while respecting teachers' agency also requires further investigation.

Measure the impact of the orchestration and orchestration load based on student learning. One interesting question raised during the workshop was “do teachers' orchestration actions reinforce student learning?” In other words, perhaps the usefulness of teachers' orchestration actions can be estimated by their impact on student learning. Understanding how different provisions of teacher support tools, e.g., mirroring and advising dashboards (van Leeuwen & Rummel, 2019) facilitate teachers' orchestration actions that enhance students' learning gains requires further investigation.

There is a need to create tools that integrate the whole progression of orchestration from planning and scripting through enactment to reflection and revision.

More attention on post-action reflection. Existing studies have focused on creating support tools to facilitate orchestration. Yet, there is a need to create tools that integrate the whole progression of orchestration from planning and scripting through enactment to reflection and revision. For example, using support tools such as teacher-facing dashboards, teachers can be provided with details about students' activity in real-time as well as

automatic summaries of how learning design was enacted and which changes to the learning design were required. Access to such information can help teachers reflect on previous learning situations and may also aid them in understanding which aspects contributed to an increase/decrease in the orchestration load. Such an understanding would facilitate a way for them to refine their learning designs for future sessions. The notion of orchestration load and technical needs of orchestration systems could be discussed within teacher professional development programs. These activities could provide opportunities for teachers to collaboratively reflect on factors influencing the orchestration load, effective use of orchestration technology, and how to reduce the load in productive ways.

Considering contextual and institutional factors. In the workshop, our focus has been mainly on the higher education teacher/instructor perspective and on the activities that occur within the classroom. Future research may also focus on the role of contextual and institutional factors that impact orchestration load in a wide range of contexts including PK-12 educators. For example, there may be institutional pressures about what and how one should teach within schools, which influence teacher behavior within the classroom. For example, the roles of administrators, standardized testing pressures, and faculty meetings need to be taken into account when defining and researching orchestration load.

Implications for practice. In this paper, we have mainly focused on the implications of what was discussed in the workshop for future research. We have provided ideas and suggestions for future research on the theoretical grounding and definitions of orchestration load in the sections above. We would like to end with a short reflection on implications for educators. One of the main ideas outlined in this report is that teachers' orchestration load is connected to different tasks that the teacher needs to fulfill (i.e., preparing for an activity, supporting the activity itself, or reflecting on the activity) and that tools may be designed and employed for each of these tasks. The implication for educators is that this distinction in tasks may be a guiding framework when choosing to implement certain technologies in the classroom. Educators may ask themselves which areas of their work are taking up the most effort (load), and try to determine what type of task that is (preparation, supporting, or reflection). Strategically choosing a tool that would support that specific task could help ease the load. Another consideration here is that when educators experience a high effort or orchestration load, it is not necessarily negative. The question that should be asked is: is the effort I am giving paying off in terms of student learning? Or is my effort disproportional? In the latter case, it may be a sign that the orchestration load is too high.

Although the current workshop mainly consisted of researchers, in the future we are planning to include educators as contributing participants. The inclusion of educators in the workshop would provide opportunities to discuss in detail their perceived role and agency during orchestration, as well as different ways of involving educators when designing appropriate teacher support tools.

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Appendix

Workshop Participants

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