THE E-TEXTBOOK AS A PLATFORM FOR INSTRUMENTAL ORCHESTRATION: LINKING DESIGN AND CLASSROOM ENACTMENT

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This paper proposes conceptualising the mathematics e-textbook as a platform for instrumental orchestration. Building on the instrumental approach, we treat the e-textbook as the locus where didactical configurations and intended exploitation are constructed through design and enacted in classroom performance. We illustrate that through a case study of a secondary teacher who designed and taught an e-textbook chapter on parallelograms. Data include observations of the design process, an interview, and a lesson recording. The analysis shows how the chapter structured a progression from a video-based introduction to GeoGebra-supported verification. The paper contributes a conceptual extension of instrumental orchestration that links e-textbook design and classroom enactment within a single analytical framework.

INTRODUCTION

Contemporary e-textbooks in mathematics are no longer merely digital versions of printed textbooks. Many now integrate videos, interactive applets, dynamic geometry applets, feedback systems, and assessment tools within a single environment. This integrative capacity is especially visible in "evolving" e-textbooks that allow teachers to author and modify content (Pepin et al., 2016). When an e-textbook is built in this way, it does not function simply as a resource to be consulted; it becomes an environment through which teachers can coordinate a constellation of resources (Greefrath et al.,2025), as part of instruction.

Research on e-textbooks has provided valuable insights into their affordances, usability, and classroom applications (e.g., Clinton-Lisell et al., 2023; Wijaya et al., 2022). However, it has been less often theorised that the e-textbook is a site where teachers organise tool-mediated mathematical activity by coordinating a set of digital resources. In other words, what remains under-specified is how an e-textbook can function as a platform in which the teacher arranges and sequences tools, representations, and tasks in ways that support particular mathematical goals, and how this organisation is taken up in classroom activity.

In this paper, we propose reconceptualising the e-textbook as a platform for instrumental orchestration (Greefrath et al., 2025). Within the instrumental approach, instrumental orchestration refers to the teacher's didactical organisation of the use of artefacts for mathematical activity, typically described through didactical configurations, exploitation modes, and their enactment in classroom performance.

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Building on this framework, we argue that the e-textbook can be treated as a locus for orchestration because it affords the teacher a relatively stable way to configure a set of embedded tools (e.g., video, applet, GeoGebra), to anticipate how these tools are to be used (exploitation), and to carry this organisation into classroom work where it is enacted and adjusted.

The purpose of this contribution is to introduce this reconceptualization and illustrate its analytical value. Using examples from a geometry chapter on quadrilaterals, we show how viewing the e-textbook through the lens of instrumental orchestration helps connect (i) what is configured in the e-textbook and the rationales that accompany these choices with (ii) how the same configuration is enacted and adapted during classroom teaching. In doing so, we offer a theoretically grounded way to link e-textbook design and classroom enactment without reducing the e-textbook to a repository of resources or treating orchestration as only an in-the-moment classroom phenomenon.

To make this proposal analytically precise, we now briefly outline the instrumental orchestration framework and specify how the e-textbook is conceptualised within it.

INSTRUMENTAL ORCHESTRATION

Within the instrumental approach, teaching with digital tools is understood not simply as using artefacts, but as organising conditions under which students develop instruments and schemes of use (Trouche, 2004; Drijvers et al., 2010). Instrumental orchestration (IO) captures this teacher work by focusing on the deliberate organisation of artefacts in a mathematical task situation in order to guide students' instrumental genesis (Trouche, 2004).

In the IO framework, an orchestration is described through three closely related components. A didactical configuration concerns how the teacher arranges the available artefacts and workspaces (for students and/or teacher) in relation to the mathematical situation at hand (Trouche, 2004; Drijvers et al., 2010). An exploitation mode concerns how the teacher intends to use a given configuration to achieve particular didactical aims, including decisions about how tasks are introduced and worked through and the roles assigned to different artefacts (Drijvers et al., 2010). Didactical performance refers to the in-the-moment enactment of the orchestration in classroom interaction, including ad hoc decisions and adaptations in response to students' mathematical work and tool use (Drijvers et al., 2010).

In this paper, we treat the e-textbook not as one artefact among others, but as a platform that integrates multiple artefacts and thus serves as a site where didactical configurations and intended exploitation can be constructed and stabilised. From this perspective, the design of an e-textbook chapter is considered part of the orchestration work (configuration and anticipated exploitation), while classroom teaching provides access to orchestration performance as teachers enact and adapt what was designed.

CONTEXT AND DATA SOURCES

This contribution draws on a case study situated within a broader project examining teachers' work as designers of e-textbooks. The wider project was conducted through a 30-hour professional development course (weekly sessions over two months) in which teachers were supported to design e-textbook materials. For most participants, including the focal teacher in this study, this was their first experience authoring an e-textbook. The present case focuses on one teacher, Sara (pseudonym), a 27-year-old secondary mathematics teacher with five years of teaching experience, working in an Arab school in southern Israel. Sara designed an e-textbook chapter on quadrilaterals for Grade 9 students (aged 15–16) and subsequently implemented this chapter in her classroom. The participating students were native Arabic speakers, and this was their first time learning from an e-textbook designed by their teacher.

To illustrate the proposed conceptualisation of the e-textbook as a platform for instrumental orchestration, we draw on four complementary sources of data. First, we observed Sara during the design process in the computer lab while she was designing the e-textbook chapter; these observations provided access to her design activity in situ and allowed us to ask clarifying questions about her choices as they were being made. Second, we analyse the designed e-textbook chapter itself as a material trace of the didactical configuration and the anticipated organisation of students' activity. Third, we conducted a semi-structured interview with Sara focusing on her planning and the rationales underlying her design decisions, particularly the roles assigned to different artefacts and tasks. Fourth, we observed and video-recorded the classroom lesson in which the chapter was enacted, documenting how the designed materials were taken up in practice.

The analysis is organised using the three components of instrumental orchestration (Trouche, 2004; Drijvers et al., 2010). The design observations, the chapter itself, and the interview are used to characterise the didactical configuration and the anticipated exploitation modes embedded in the e-textbook. The classroom observation is used to examine orchestration in performance, focusing on how Sara enacted, adapted, and sometimes reconfigured the designed organisation through whole-class work, student work, and ad hoc decisions during the lesson.

The purpose of this paper is not to provide a representative account of teachers' e-textbook design practices, but to use a well-documented case to illustrate the analytical potential of the proposed conceptualisation. The single-case design allows for a fine-grained examination of how the e-textbook can be analysed as a platform for instrumental orchestration across both design and classroom enactment.

ILLUSTRATING THE E-TEXTBOOK AS A PLATFORM FOR INSTRUMENTAL ORCHESTRATION

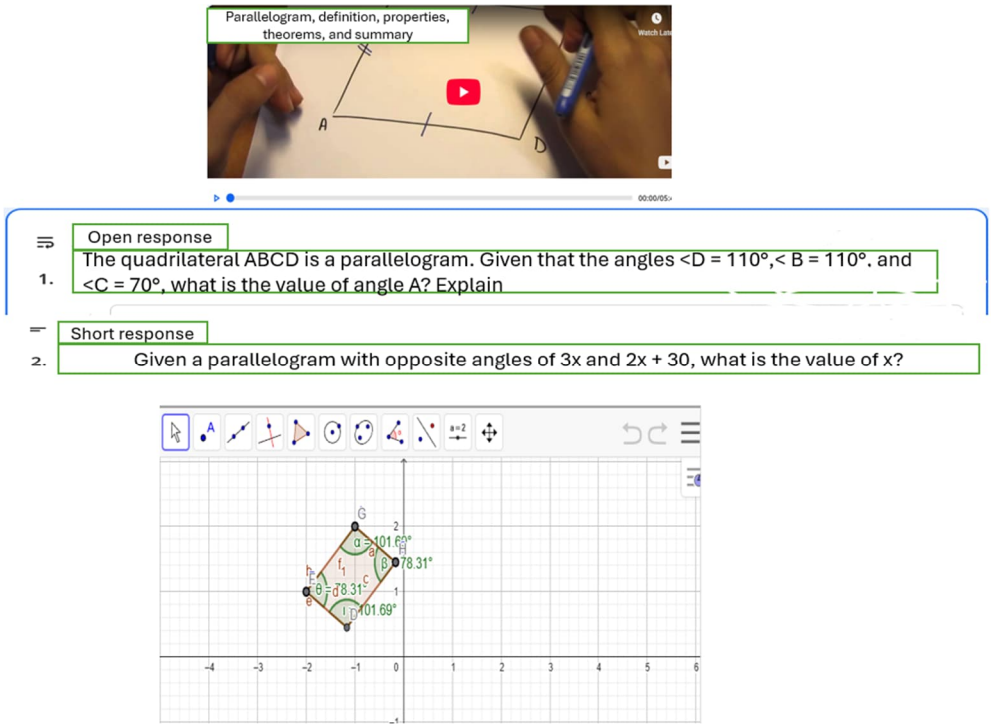
Orchestration in design: didactical configuration and anticipated exploitation

Sara designed an e-textbook chapter on parallelograms consisting of 13 items. The chapter opens with a video introducing the properties of a parallelogram, followed by two open-ended questions that ask students to articulate what they observed in the video (Figure. 1). According to Sara, these questions were intended to guide students' attention toward specific mathematical ideas and to structure how the video should be interpreted. She said:

The video explains the relationship between the angle of the parallelogram. It also includes an example of calculating the angles of the parallelogram. So, I designed the two tasks to be similar to what is explained in the video.

This opening sequence already indicates that the e-textbook is not organised as a simple collection of resources, but as a structured progression in which different artefacts are assigned distinct roles.

Fig 1: Part of the configurations of Sara's chapter



The fourth item in the chapter is a GeoGebra applet displaying a draggable parallelogram with angle measures. Sara explained this design choice as follows:

> I use GeoGebra here, which has a role in terms of accuracy in geometry; it allows students to calculate the opposite angles of a parallelogram accurately, and it's good to incorporate it into the digital book after the tasks related to watching the video.

This justification shows that GeoGebra is deliberately positioned after the video-based tasks and assigned a specific mathematical function: supporting precise measurement and validation. From an instrumental orchestration perspective, this organisation constitutes a didactical configuration in which the video is positioned as a tool for initial exposure and interpretation, while GeoGebra is positioned as a tool for verification and accuracy. The sequencing of these artefacts encodes a progression in students' activity from observing and articulating properties to checking and validating them through measurement.

In addition to the video and the GeoGebra applet, the chapter includes further resources such as drawing tools, embedded hints, and images of different types of parallelograms. These elements extend the configuration and provide support for different aspects of the work. Sara reported that she designed the tasks to be relatively accessible so that students would experience success, and that she embedded hints in some tasks so that students could request help when needed rather than having it imposed on them. For example, she noted:

> I loved the idea that it is possible to give a hint during the design… students can click to see the clue; it doesn't have to be visible.

This indicates an anticipated exploitation mode in which students are expected to work largely individually, with optional scaffolding available on demand.

Taken together, the structure of the chapter, the sequencing of video and GeoGebra, and the inclusion of optional hints show how the e-textbook functions as a platform in which both the didactical configuration and the intended exploitation are inscribed in advance. Design here is not merely the selection of resources, but the construction of a didactical organisation that anticipates how students will move between tools and how these tools will function in the mathematical activity.

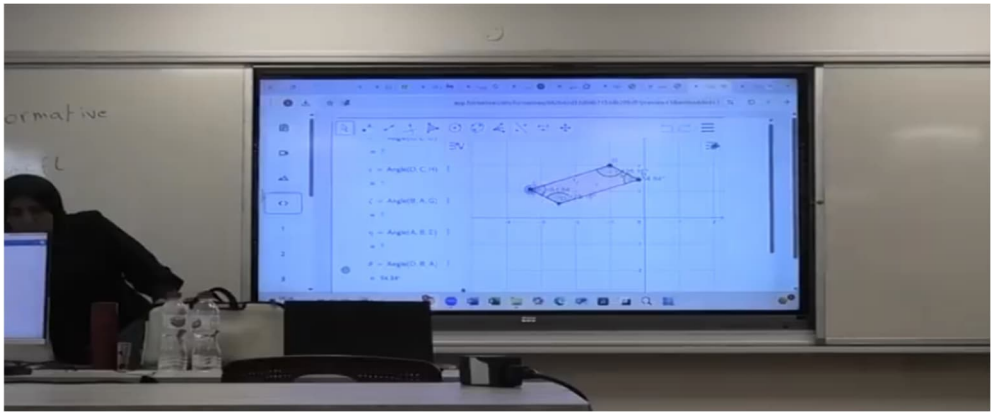
Orchestration in performance: enacting and adapting the configuration

The classroom enactment shows how this designed organisation is taken up and adapted in practice. At the beginning of the lesson, Sara demonstrated how to access the e-textbook and asked students to watch the introductory video and answer the accompanying questions. Students then worked at their own pace, each controlling the video and beginning to solve the tasks individually. This phase closely follows the designed configuration and its anticipated exploitation: individual work, guided by the video and the embedded questions.

Later in the lesson, Sara shifted to a whole-class mode of work. Using an explain-the-screen orchestration, she manipulated the GeoGebra applet in front of the class (see Figure 2), moving the vertices of the parallelogram while discussing with students that the opposite angles remain equal. She said:

> Students, notice that when I drag one of the vertices of the parallelogram, the opposite sides remain equal, and the size of the opposite angle also remains equal.

Fig 2: The teacher uses GeoGebra to drag the parallelogram vertex.

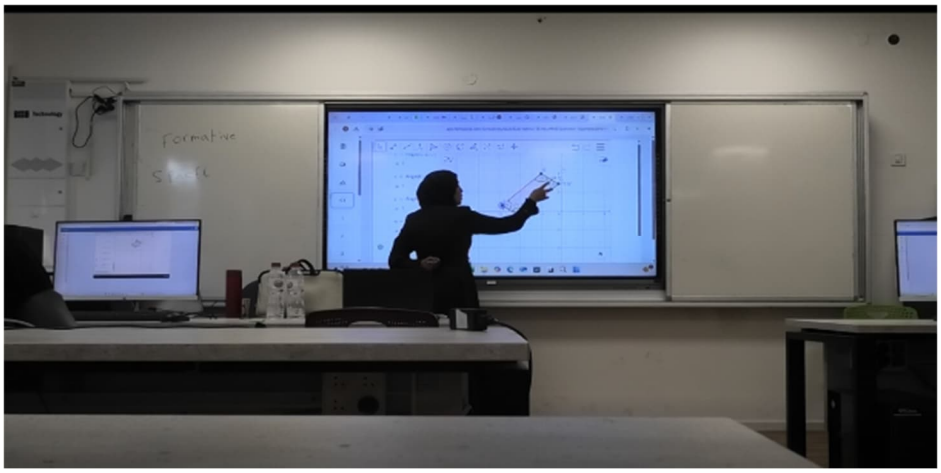


This episode makes visible how the verification role assigned to GeoGebra in the design is realised in performance: the dynamic manipulation of the figure is used to make the invariance of the angles perceptually and mathematically salient.

Here, the affordance of movement becomes central. The teacher's actions show that the configuration is not merely executed but actively performed: GeoGebra is used not only for numerical checking, but also as a means to support collective discussion about geometric invariants (see Figure. 3).

As the lesson progressed, Sara also made ad hoc orchestration decisions in response to students' needs. Several students asked for help, both with the technical use of the e-textbook and with the mathematical tasks. In these moments, Sara approached individual students, stood next to their screens, and guided them on how to calculate the angles of the parallelogram using GeoGebra. These interventions were not explicitly scripted in the e-textbook, but they are clearly oriented toward steering students' instrumental genesis, both with respect to the digital tools and the mathematical content.

Fig.3: Saras' explain the relationship between two opposite angles in a parallelogram.



From an instrumental orchestration perspective, these episodes illustrate orchestration in performance: the teacher enacts the designed configuration, extends it through whole-class explain-the-screen moments, and adapts it through individual interventions. The e-textbook thus does not replace teacher orchestration; rather, it provides a structured platform within which orchestration is continuously performed, adjusted, and refined in interaction with students.

Discussion: What does conceptualising the e-textbook as a platform for instrumental orchestration afford?

The purpose of this paper was to propose and illustrate a way of conceptualising the e-textbook as a platform for instrumental orchestration. The analysis of Sara's chapter and its classroom enactment shows that this perspective offers more than a descriptive account of "using digital resources": it provides a coherent language for linking the organisation of digital materials, the teacher's anticipations, and the situated work of teaching.

First, this conceptualisation makes the design of the e-textbook analytically visible as a form of orchestration work. Rather than treating the chapter as a collection of resources (video, GeoGebra, hints, tasks), the IO lens allows us to interpret its structure as a didactical configuration in which different artefacts are assigned specific roles and sequenced to support a progression of activity (from observation to verification). The teacher's explanations further show that these design decisions are not merely technical or aesthetic, but are guided by anticipated exploitation modes, such as working individually with optional support and using GeoGebra as a tool for accuracy and validation. In this sense, design appears as orchestration-in-anticipation, inscribed in the e-textbook itself.

Second, the same lens allows us to analyse classroom use as orchestration-in-performance without breaking the continuity with design. The lesson does not simply "implement" the chapter; rather, the teacher enacts, extends, and adapts the configuration through explain-the-screen moments, pacing decisions, and individual interventions. Seeing the e-textbook as the platform of instrumental orchestration helps account for both the stability of the planned organisation (e.g., the video–GeoGebra sequence) and the flexibility of its realisation in interaction with students.

Third, this perspective shifts attention away from the tools themselves toward the organisation of students' mathematical work across tools. GeoGebra, for example, is not analysed as a powerful tool in general, but as a tool that is assigned a specific role within a configuration and exploited in particular ways during teaching. This avoids tool-centric or feature-based accounts of e-textbooks and instead foregrounds the teacher's professional work of coordinating artefacts, representations, and participation structures.

At the same time, the scope of this study is intentionally limited. The single case is used here as an illustrative case to demonstrate the analytical potential of the proposed

conceptualisation, not to make claims about the prevalence of particular design or teaching practices. Future work could examine how different teachers construct different types of orchestrations within e-textbooks, and how these relate to broader pedagogical orientations or institutional constraints.

Overall, conceptualising the e-textbook as a platform for instrumental orchestration provides a way to understand digital textbooks not as containers of content, but as structured environments in which orchestration is designed, anticipated, and performed.

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