

Reflecting on didactic metadata of learning sequences

Jason Cooper¹, Shai Olsher² and Michal Yerushalmy³

University of Haifa, Israel

jasonc2107@gmail.com; olshers@edu.haifa.ac.il; michalyr@edu.haifa.ac.il

With the emergence of e-textbooks, together with expectations to integrate technology in instruction, teachers are coming to take an active role in designing the curriculum they teach. In order to maintain instructional coherence, teachers need to develop sensitivity to various didactical aspects of the curriculum. We suggest the use of novel tools for tagging didactic metadata of learning resources, and for representing learning sequences from the perspective of this metadata. We report on an ongoing experiment with practicing teachers. Over a period of several weeks, participating teachers tag all of the learning objects that they use in class, construct various representations of the taught curriculum, highlighting different didactic aspects of the sequence, and reflect on the instructional coherence of the sequence in light of these representations. We ask what effect this intervention may have on teachers' pedagogical design capacity.

Keywords: Tagging, instructional coherence, pedagogical design capacity.

Literature review and theoretical framework

The linear arrangement of conventional textbooks implies a “teaching sequence” of the intended curriculum – a collection of learning activities to be undertaken in a particular order. Yet, in enacting the curriculum, teachers may change the sequence, adding and removing tasks, or ordering tasks differently from the author’s intention. In so doing, teachers are exercising *pedagogical design capacity* – “their ability to perceive and mobilize existing resources in order to craft instructional contexts” (Brown, 2009, p. 24). Such changes can influence *instructional coherence* of the intended curriculum in significant ways, for example, Yerushalmy and Chazan (2008) have shown that sequencing can influence ways in which inherent discontinuities in the content are addressed. As e-textbooks become more common, teachers are taking a more active role in designing sequences of activities. This is especially true in the case of the interactive model of e-textbooks (Pepin et al., 2015), where tasks and interactives can be linked and combined in different ways. This emerging practice is blurring Pepin et al.’s distinction (2015) between the *coherence of design* of a textbook (in its intended curriculum) and its *coherence-in-use* (as enacted).

Whatever model of textbook is in use, the instructional coherence of the intended and the enacted curricula is liable to remain opaque to teachers. To address this, we are developing a coupled pair of tools to support teachers as co-designers of curriculum: a tagging tool for associating didactical metadata with learning resources, and a tool for representing and navigating a collection of tagged resources. The overarching question that guides our research is: How do these tools, along with the categories of metadata that they support, influence teachers’ curricular discourse, and in particular, their pedagogical design capacity? In addressing this question, we follow Drijvers & Trouche (2008) in focusing on two complementary aspects of *instrumental genesis* of these tools; *instrumentalization*

is the process by which subjects shape the instrument and its use, and *instrumentation* is the process by which the artifact influences subjects' activity and thinking. Both these aspects influence and are influenced by teachers' pedagogical design capacity.

Our broader research project can be described along two orthogonal dimensions; A. We are investigating both intended curricula (textbooks, or teachers' curricular planning), and curricula as enacted by teachers; B. We view these curricula in terms of *balance* – relative prominence of various types of learning resources – and of *sequence* – the order in which these learning resources are presented. Our research to date has focused mainly on textbook balance (see Cooper, 2017 for an overview). In the present report we turn our attention to the balance and sequencing of enacted curricula, and ask: What are the affordances of tools for tagging and representing didactical aspects of learning sequences as a means for eliciting and promoting teachers' pedagogical design capacity?

Methodology

The study described herein is taking place in the 2017-2018 school year, currently with the participation of 2 secondary-school teachers in Israel over approximately 8 weeks of teaching.

- For each learning resource used (e.g. tasks), teachers tag didactic metadata (see the following section for some categories of metadata), pertaining to both *design* (e.g. nature of operations on mathematical objects, type of student interaction with technology, available representations) – and *use* (e.g. class arrangement, duration, class-work or homework).
- Researchers independently tag the learning objects in the first two weeks, as validation for the teachers' tagging. Discrepancies are discussed and resolved with the teachers.
- At the end of the 8-week teaching period we prepare “representations” of learning the sequence from two perspectives – balance and sequence (see appendix).
- We are conducting semi-structured artifact-based interviews with teachers, through which we elicit the meaning that they ascribe to categories of metadata, and their significance in reflecting on didactic aspects of the enacted sequence.

Analysis and findings

Our analysis begins with representations of the tagged sequences, in which we search for patterns. Findings will later be discussed with teachers, to elicit aspects of their design capacity. We expect patterns of three types: 1. Intentional results of teachers' thoughtful sequencing; 2. Unintentional yet reasonable upon reflection; 3. Unexpected or surprising. Patterns of the 2nd and 3rd type will serve as a springboard for discussing alternatives to the sequence that was enacted.

We have analyzed one teacher's tagged sequence and present preliminary findings, noting that their significance will emerge through interviews which will be conducted and analyzed at a later date.

Balance: Tasks tagged as *modeling* tend to have a prominent *numeric representation*; tasks tagged as *transforming* have a prominent *symbolic representation*, longer tasks (15-45 minutes) require *drawing conclusions*, are arranged for *individual work*, and do not include *numeric representation* (see Figure 1 in appendix).

Sequencing: The object *circle and points* is sequenced spirally – in consecutive tasks at the beginning of the sequence, and then intermittently (Figure 2A); similarly, *graphic representations* is minimal at

first, is high in a number of consecutive tasks, and then returns intermittently (Figure 2B); *numeric representation* is prominent at the beginning of the sequence, and later fades (Figure 2C); *whole-class* activities appear once every lesson (Figure 2D).

Interviews with teachers will be analyzed to characterize teachers' curricular discourse, focusing on their considerations in selecting and sequencing tasks.

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Appendix: Representations of a learning sequence

Figure 1 is a screenshot of the balance representation tool, developed on an open platform for data analysis (Keshif LLC). Locking on a value of metadata (in this case the value *medium* in the category *duration*) highlights the relative prominence of these tasks within categories of the collection.

Figure 2 includes screenshots of the sequence representation tool, developed on the same open platform. The tool shows the progression over time of each category of metadata.

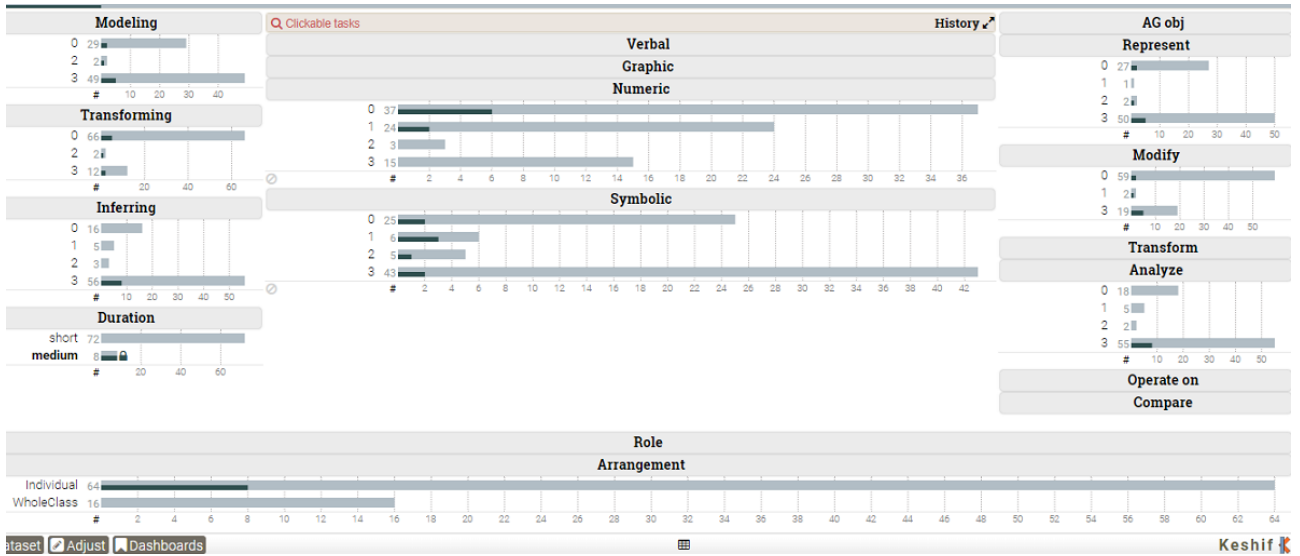


Figure 1. Dashboard representing balance of the sequence. Locking on medium duration, we see that all 8 of these tasks require *inferring and drawing conclusions* (at level 3), were arranged as *individual* activities, and do not include *numeric representation*.

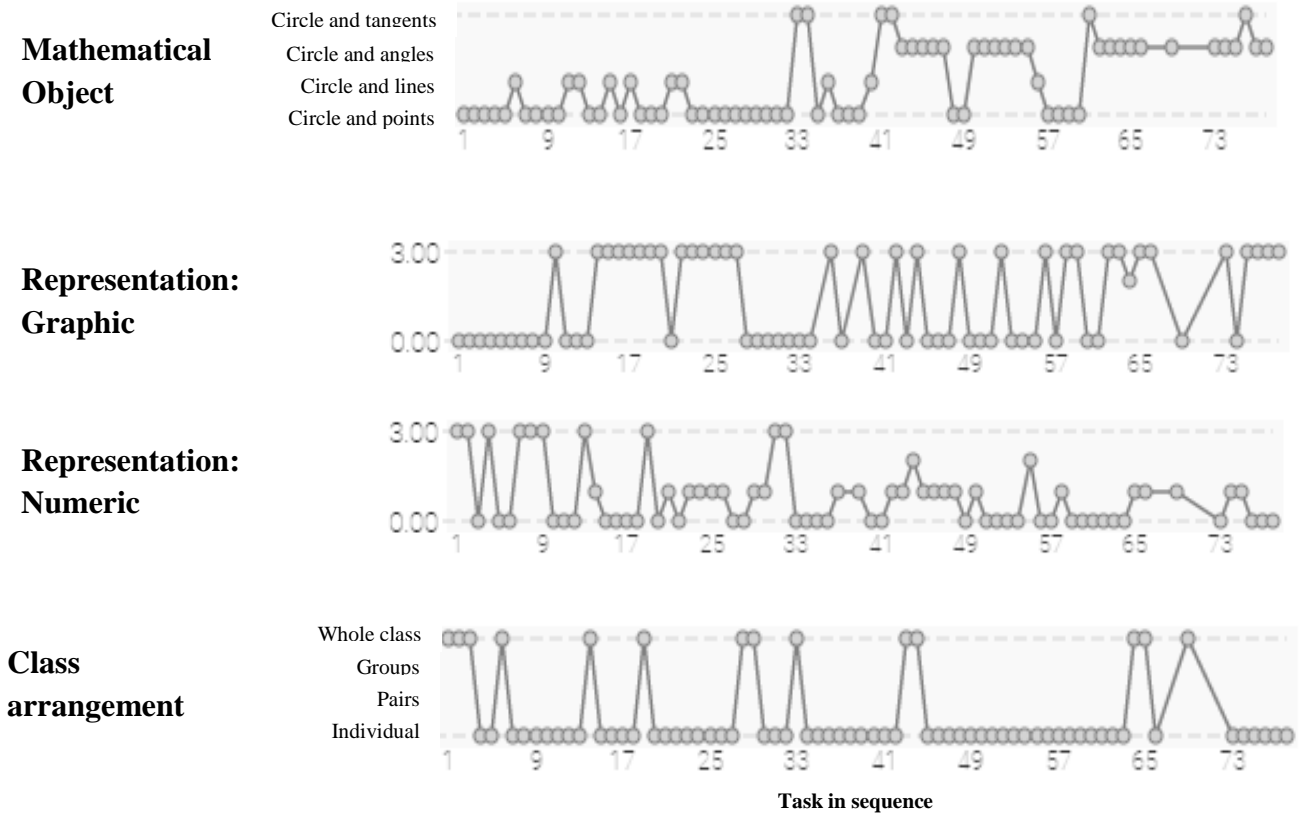


Figure 2. Representing the sequence of tasks from 4 perspectives, corresponding to 4 categories of tagged metadata.