

ILLUSTRATING A METHOD FOR ANALYZING MULTIMODAL ARTIFACTS USED IN TRANSACTIONS OF PRACTICE

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We illustrate how concepts from systemic functional linguistics are adapted for the analysis of multimodal representations of practice used in activities where teachers and teacher educators transact meanings about practice. We focus on the transactive register used to project practice meanings to the audience of these representations. We showcase the systems called visibility (how much of the classroom experience happening is made visible to the viewer), temporality (how sequence and duration of events are represented), and theme (how semiotic resources maintain and develop themes). We apply these systems to examine the differences between two storyboards of algebra lessons that were used in a professional development context and the different kinds of reactions teachers offered to the different storyboards.

INTRODUCTION

We contribute to the examination of teachers' learning with multimodal representations of practice (RoP). Teacher educators (TE) have long been using RoP, in the form of various media types (e.g., written cases, videos, simulations, transcripts, animations, storyboards) to engage (prospective or practicing) teachers in activities where they can learn in, from, and for practice (Lampert, 2010). Whilst RoP might be differentiated by their media types, they also have common characteristics that issue from their multimodality, purpose, and subject matter. We offer a multisemiotic analysis of RoP that especially accounts for how they support transactions of practice between TE and teachers. We tackle the question: When teachers annotate a multimodal RoP, what aspects of the RoP need to be analyzed apriori to make sense of their comments? We illustrate our analytic approach by focusing on storyboards designed with cartoon characters and raise the question of how different semiotic choices relate to how practicing algebra teachers engage with the represented practice.

THEORETICAL FRAMEWORK

This paper provides empirical illustration of the theoretical contribution by Herbst, Chazan, and Schleppegrell (2023), which draws on systemic functional linguistics (SFL; Halliday & Matthiessen, 2004) to organize the multimodal resources available to producer and consumer of a storyboard to construe meaning. While SFL was originally developed for language, various extensions to other semiotic systems (e.g., displayed art, children's picture books, film; O'Toole, 2011; Painter et al., 2013; O'Halloran, 2004) have encouraged us to extend it to the case of RoP. Storyboards are sequences of frames, each of which includes graphics and written language, which are commonly used in the design of animations, films, and graphic novels; they have been used in teacher education and in research on teaching for more than a decade and

sometimes called comics, vignettes, or scenarios (Friesen & Knox, 2022; Herbst et al., 2011; Lin, 2023). Like the children's picture books analysed by Painter et al. (2013), the combination of images and writing make storyboards a multimodality with which the multimodality of classrooms (i.e., the use of oral and written language, gesture, body language, and facial expression) can be represented and transacted. Herbst et al. (2023) used SFL's metafunction dimension to organize the search for and identify some of the systems available in the storyboard modality to make meaning.

The metafunction dimension of SFL proposes that multimodal texts in a semiotic system fulfill three different metafunctions: (a) ideational – to represent the world and the experiential and logical relationships in the world, (b) interpersonal – to relate transaction partners, particularly producer and consumer, and (c) textual – to characterize types of texts. In this paper, we define and illustrate three multimodal systems at play in storyboards of practice—temporality, visibility, and theme—which contribute respectively to the ideational, interpersonal, and textual metafunctions.

SFL's founder M. A. K. Halliday originally proposed the notion of register to describe patterns in the use of elements of language in social context (see Matthiessen et al., 2010, p. 176). Thus, the mathematical register is a variation of language used to make mathematics meanings (where words like center or let are used differently than in everyday English). As SFL has become a social semiotic, capable of analyzing texts in diverse modalities, register has come to be identified with three elements that specify its context: Field (what the communication is about), Tenor (what social relationships are enacted through communication), and Mode (what kinds of texts are used). Christie (2002) contributed to bring SFL closer to education research by identifying two registers in classroom language: The instructional register (used to communicate the content of instruction and apparent, for example, in how a textbook might display the solution of an example problem) and the regulative register (used to organize pedagogy and the classroom experience; Schleppegrell & Oteiza, 2023). Christie characterizes classroom discourse by saying that the regulative register projects the instructional register—patterns of pedagogical language use are used to communicate patterns in mathematical language use. Storyboard RoP are multimodal texts whose ideational metafunction includes representing classroom actors and events. Those RoP used in teacher education or professional development support and help constitute relationships between teacher learners and teacher educators. And they do so in the form of lesson representations to be perused or annotated, lesson plans to be created collaboratively, or exercises in which teachers have to complete or select missing elements of the RoP (Kaliniec-Craig et al., 2021; Rougée & Herbst, 2018). Perhaps the case of transcripts is the clearest illustration that representations of practice are not equal to events of classroom practice—a RoP actually uses signs to project the regulative and instructional registers of classroom practice. Herbst et al. (2023) introduced the notion of transactive registers to name patterns of use of semiotic choices to represent classroom practice for transactions among social actors and through particular texts. Though some transactive registers are also in play in

instruments designed for research on teaching (e.g., Skilling & Stylianides, 2020), we focus here on the register used in transactions of practice in teacher education.

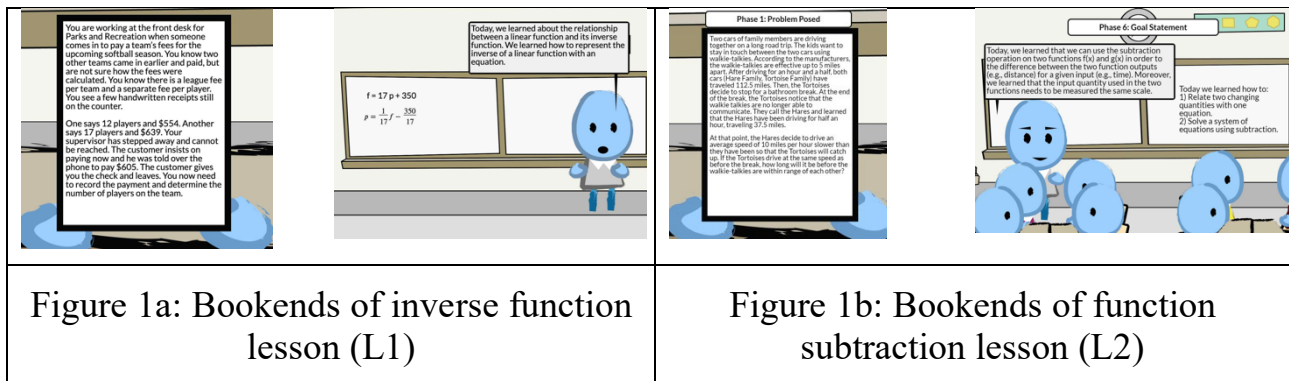
The transactions of practice that take place in teacher education are more than opportunities to peer over a classroom experience; they rather are pedagogical encounters, and multimodal resources are used in particular ways to enable those RoP to be pedagogical. Thus, the transactive register consists of semiotic systems of choice to construe field, tenor, and mode of situations which constitute the pedagogical relationship among teachers and TEs about practice.

We illustrate how the transactive register allows us to examine records from transactions of practice, specifically two commentaries of algebra lessons. The lessons were represented using storyboards that had similarities and differences. The RoP can and should be examined in terms of what mathematical and pedagogical meanings they construe, but we concentrate here in illustrating the teacher education meanings construed with the transactive register. We look at those in terms of three transactive systems of meanings. One is visibility, which supports the construal of interpersonal meanings (or the tenor of the relationship between producers and viewers) by making classroom experience more or less visible for the participants of the teacher education transaction: For example, in a storyboard, the designer may choose to provide whiteboard content which is interpretable by the viewer (e.g., an inscription in legible mathematical symbols) instead of providing indices that suggest content is on the whiteboard though it cannot be retrieved by the viewer (e.g., a scribble); this suggests that the RoP producer may intend the receiver to read the specific content rather than expect the receiver to bracket it. The second is temporality, which supports the construal of ideational meanings by developing of a sense of sequence and duration of events in the lesson. For example, the left-to-right juxtaposition of frames to indicate before-after sequences of events, or the possibility to insert a frame in between to frames to represent events that avowedly happened between the events represented in the original two frames. The third system is theme, which in the analysis of paragraphs in language refers to progression from the setting of a topic to comment on the topic, to the topicalization of elements of that comment. For the analysis of storyboards, we identify multimodal resources that support a sense of continuity and progression of themes. In this analysis, we identify resources that construe themes across frames. The development of a lesson requires the passing of time and the evolution of discourse. What are the resources that permit the reader to understand new frames as dealing with the same lesson even when elements of prior frames are not present in new frames and what are the resources that permit the reader to identify what is new in each frame?

MODES OF INQUIRY AND DATA SOURCES

Analyzed data comes from *StoryCircles* (Herbst & Milewski, 2018), a professional learning program where teachers participate in online activities of scripting, visualizing, and arguing about a lesson. In this paper, we discuss how RoP were used in two *StoryCircles* focused on problem-based algebra lessons that teachers were to

represent during a six weeks period. Figure 1 provides the opening and closing frames of the two lessons, which were among the storyboard frames given to participants.



Each StoryCircle started with a transaction of practice named “Leave Tracks” where participants (8 and 6 teachers, respectively) were asked to review and annotate a sequence of lesson frames and then answer questions posed, using an annotation application. The design of the two activities differed, as did the ensuing teacher comments; these differences illustrate analysis of the transactive register. We performed a dual analysis of the two activities. An apriori analysis compares the design of the activities in terms of visibility, temporality, and theme. And an aposteriori analysis describes teacher comments in relation to design choices and to program goals.

The RoPs provided to teachers represented lessons which started with a novel mathematical task and ended with the teacher introducing a specific instructional goal as a conclusion of the work on the task. The two RoPs represented similar lesson structure: The teacher launched the task, the students had time to work on it, a whole-class check-in happened after, and the teacher redirected the class to continue working, followed by a whole-class discussion that eventually led to the instructional goal. However, within these similarities the RoPs represented the lessons differently, as we elaborate next. We focus on the moment of the lesson when the teacher redirects the work on the task to make progress toward the lesson goal.

RESULTS

Apriori comparison of the two storyboards

We compare the way the lesson was offered to participants in cycles 1 and 2 in terms of *visibility*, *temporality*, and *theme*; because of space limitations we only share illustrative instances. The inverse function lesson (L1) was represented with a 20-frame storyboard (see Figure 2). In terms of *visibility*, viewers were able to see the teacher, more than a dozen students, the actual writing on the board (in frame 12), and the specifics of what was said. In addition, the text on the board is not hand-written, which could have been a more accurate representation of classroom practice; instead, there was a deliberate choice to make the text readable, at the expense of authenticity. In comparison, in the subtraction of functions lesson (L2) much less is visible: Figure 3b shows a moment of redirection of students’ work on the problem in frame 7, and Figure

3a the frame immediately before, but in both cases no board content is to be scrutinized. Furthermore, although the frame zooms-in on the teacher, viewers don't see what's on the board, and they see only about six students, but with very little evidence on what they are doing. We suspect that this low visibility might prompt viewers to imagine, speculate, and eventually script what could have happened. The details visible in L1 might not invite the same behaviors from readers.

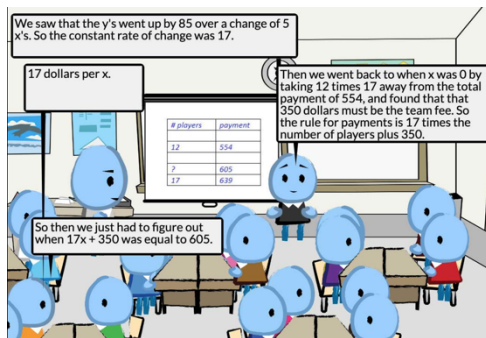


Figure 2a - Frame 12 in L1

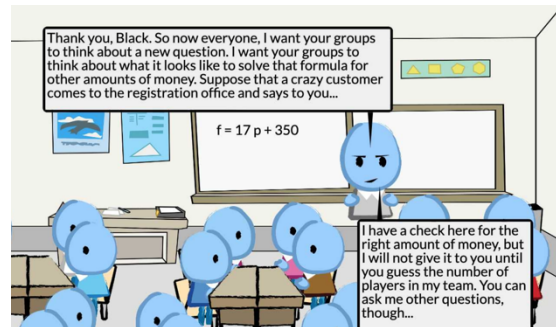


Figure 2b - Frame 13 in Lesson 1

In terms of temporality, in both lessons the serial layout of the frames in the storyboard organizes events in the order in which they happened over time. Yet, they convey different senses of time, using the gutter between frames and ordered actions and speech within each frame. The gutter is used in the comic genre to separate frames and can be used, similarly to a jump cut in video, to fast forward action. The gutter in L1 was used as follows: in frame 13 the words “Thank you, Black” indicate the teacher wrote the equation immediately after the student shown in Frame 12 (wearing a Black vest) presented their solution—signaling that only a few seconds passed between the frames. This sense of temporality may also lead viewers to infer that the teacher was the one who introduced the two variables, including choosing f and p to represent them, since there could not be a major scene omitted in between the frames. In L2, however, the gutter between frames 6 and 7 together with the captions perform a jump cut to a new scene, conveying the sense that significant time has passed between the frames. L1 thus represented a denser temporality (less time between frames), while L2 represented sparser temporality (more time between frames).

To assert that storyboards of practice fulfill a textual metafunction means that each storyboard contains resources that allow it to hang together as one text just as new frames introduce new material. In Figure 2 we note the intersemiotic repetition between Black's statement “17 times the number of players plus 350” in Frame 12 and the inscription “ $f = 17p + 350$ ” the teacher made on the board visible on Frame 13. The formula was the comment made by Black on Frame 12 about “the rule for payments” which was the theme. In Frame 13 the formula becomes the theme as the teacher poses a question to the whole class about manipulating the formula. The shot is the same and suggests graphically that the speaker in Frame 12 who was then at the front of the class is back in their seat. That is, the juxtaposed frames not only represent a short time between two events but also permit the analysis of theme development in ways similar

as in ordinary discourse analysis (albeit, considering also the repetition and change in graphics). In Figure 3, however, fewer language resources help in the same way. The constancy of the shot and apparent arrangement of the classroom helps suggest these frames are part of the same story. Similarly, the caption is an important resource both for repetition and change. The word “Phase” repeated across frames makes them part of a same story (that one might surmise develops in phases) and the change from 3 in Frame 6 to 4 in Frame 7 suggests that they are consecutive and this enables the inference from the reader that after a discussion of what students had found on the initial problem (presumably Phase 3 of the lesson), the teacher gave them a variation of the problem (announced in Frame 7).

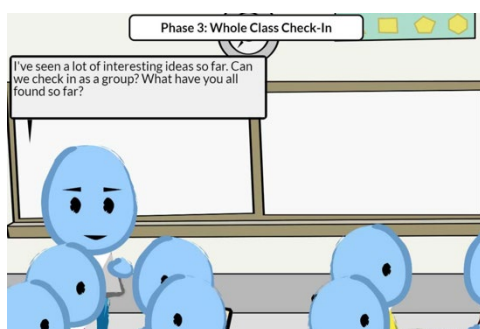


Figure 3a. Frame 6 in L2

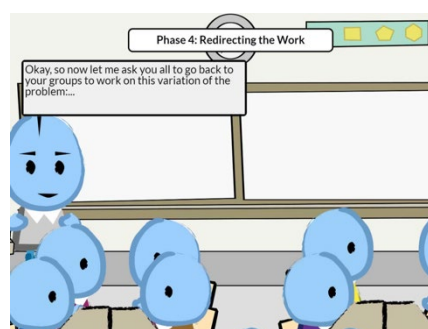


Figure 3b. Frame 7 in L2

A Posteriori comparison of teacher commentaries

We present here representative examples of participants' responses to the two activities, focusing on the different ways in which participants described the teacher's moves. Comments on Frame 13 (L1) were characterized by appraising the teacher's move, either negatively or positively. However, this was done in different ways. One participant placed himself as an outsider to the situation:

I like the extension/generalization to other situations... and bundling it into a "real"-ish story.

Another participant put himself in the scenario, though without agency to change the represented move:

I'm trying to think how my students would respond here since the teacher is giving them two unknowns now. I can imagine this frustrating some students; which isn't necessarily a bad thing. I think the questions that the students ask on the next few slides kind of display this frustration.

But a third participant put herself in the teacher's shoes and suggested an alternative move:

I probably would have given each group time to adjust their answers to follow what was shared with the class before moving on to a new problem.

This last comment negatively appraises the represented move, by arguing students needed more time. We suggest this criticism was supported by the temporality choices

discussed above, which conveyed the sense that only a few seconds had passed between frame 12 where a student showed their solution, and frame 13.

Overall, we argue that the appraisals shown above are supported by the choices of denser temporality and high visibility of the events in the lesson through the representation that was offered to the participants in L1. The temporality and visibility systems were used to convey the sense that what was visible to the viewers is more or less what happened in the lesson, similarly to when watching videos of practice.

In L2 comments on the redirection moment (L2-7) were different. A first noticeable difference between the cycles is that the participants suggested what could be done:

Perhaps [the teacher should] give some noticing... ["I see some great strategies so far that are helping you find out when the vehicles will be within that 5-mile range"]...["it was nice seeing a variety of representations"]... ["this group has tried using a graph to represent the situation"]... ["this group has started with a table"].

However, that was not always subject specific, as the following comment shows:

The teacher could talk with the students about the pros and cons of each of the different ideas that the students have come up with.

This suggests that a sparser representation with no visible student work may not be enough to support participants' engagement in scripting both the regulative and instructional registers of classroom discourse. L2 had been created purposefully sparser, as our discussion of theme suggests, to engage participants in scripting the various phases of the lesson. But the generic nature of this sparse representation was apparently not sufficient to get participants to specify alternative actions. The facilitator was able to get teachers to act on the suggestions from the comments by bringing in samples of students' work (as described in Brown et al., 2021).

CONCLUSION

We illustrated how different choices in the transactive register can be associated with different types of participants interactions with RoP. A denser storyboard (one with denser temporality, more visibility, and subject-specific markers of thematic development) enabled substantive, albeit reactive comments. A sparser storyboard in contrast did enable some suggestions for what to do in between but these suggestions stayed generic during the perusal of the storyboard. Quite often when creating representations of lessons for their use by teachers, teacher educators need to make choices that include selecting, editing, and augmenting media. This suggests that designers can finetune the RoP they present to teachers in anticipation of the kinds of engagement with the lesson they want to enable (e.g., when deciding how to edit and present a video of a lesson). The systems of visibility, temporality, and theme are among the systems that can assist designers in making those design choices.

Additional information

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