

## **DIRECTING FOCUS AND ENABLING INQUIRY WITH REPRESENTATIONS OF PRACTICE: WRITTEN CASES, STORYBOARDS, AND TEACHER EDUCATION**

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*We discuss affordances and liabilities of using a storyboard to depict a written case of a teacher's dilemma that involves race, opportunity to learn, and student community. We rely on reflections by the teacher educator who authored the written case and later depicted it as a storyboard to use it with his preservice teachers (PSTs). The analysis involved, first, organizing the signifiers in each of the two representations of practice into what we call concentric spheres of stratification, and secondly, contrasting the various meanings attributed to signifiers by both the author and his PSTs. We suggest that the resources of storyboard allow for more inquiry and alternative narratives than is available from the single modality of text in the written case.*

Keywords: Equity and Diversity, Teacher Education-Preservice, Technology

### **Introduction**

Motivated by the increasing use of multimodal representations of practice (e.g., video, animations, storyboards) in mathematics teacher education, we discuss affordances and constraints of such media and propose a framework for analyzing them. This contribution helps address the challenge of anticipating what meaning a group of preservice teachers (PSTs) will attribute to the complex system of signifiers included in a representation. The framework addresses this issue by offering a way of organizing those signifiers and suggesting that teacher educators could consider where and how the meanings that they and their PSTs attribute to a given representation might differ. To demonstrate the value of the framework, we use it to analyze a teacher educator's use of a written case and a storyboard representation of the same classroom scenario. The scenario was used to discuss a teaching dilemma that involves race, opportunity to learn, and student community – the decision to move a student to a more advanced mathematics class. The data comes in the form of the reflections by the teacher educator (and co-author) who initially wrote the case and then created a storyboard for use with his PSTs. We examine issues of representation illustrated by that data and that concern the use of representations of practice to support practice-based and inquiry-oriented teacher education.

### **Perspectives and Theoretical Framework**

The notion of *representation of practice* has been a key in developing a practice-based approach to professional education (Grossman, et al., 2009). Representations of practice using the written narrative modality have been common in professional development (e.g., Stein, Smith, & Silver, 1999). Written cases are useful because they can help focus attention on important aspects of practice. But inasmuch as written cases use abstract symbols (words!) to represent individuals,

settings, and actions of practice, they are less effective in immersing their audience into key aspects of classrooms such as the simultaneity and temporality of classroom events (Doyle, 1986; see also Herbst et al., 2011). As video technology became more accessible and approaches to teacher education as inquiry more common, teacher educators have been using video records to immerse novices in practice (Brophy, 2004; Lampert & Ball, 1998). Much has been written describing the affordances of having teachers watch and discuss classroom video to promote noticing and reflection (Rich & Hannafin, 2009; Sherin, Philipp, & Jacob, 2011). The capacity of video to record simultaneous multimodal communication (gesture, inscription, voice, movement, etc.) by a diversity of individuals has been noted as advantageous for creating an increased sense of presence (e.g., in comparison with text; see Kim & Sundar, 2016). That capacity also provides key affordances to allow for expanded inquiry pursuing a variety of foci, though the camera always directs attention in some way (Hall, 2000). This is not always what teacher educators need or prefer, as quite often their students latch onto aspects of a video not particularly germane to the goals of their instructors (Star & Strickland, 2008).

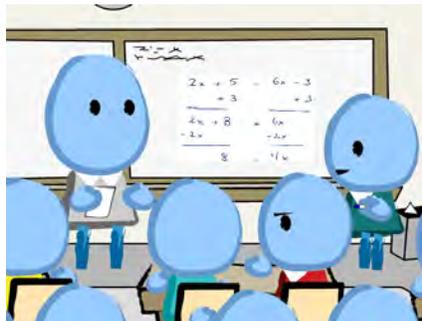
To bridge the gap between the capacity of video to immerse and the capacity of text to focus, professional educators have started to explore other media (e.g., animations and storyboards with cartoon characters) to represent practice (see Herbst et al., 2011; Tettegah, 2005). Art critics and scholars of visual communication have for long used language as a metaphor in examining visuals (Barthes, 1972). But more recent progress extending the systemic functional linguistics approach to language (Halliday & Matthiessen, 2004) to a variety of sign systems (Kress & van Leeuwen; 1996) and levels of realization (including the register of classrooms; Christie, 2002) has brought us closer to actually being able to examine the affordances of the comics medium as a language using similar approaches and resources as how SFL examines the uses of language. This paper contributes to an examination of how the multimodal resources in the comics and animation medium permit the production of complex messages about classrooms and the way in which they also enable a degree of openness (Weiss, 2011) that allows for inquiry and alternative narratives. Some of these features of comics will be exemplified through a comparison of a comics-based representation and a written representation of a classroom story.

### Mode of Inquiry

We collaboratively examined the interaction of a teacher educator (Lawrence Clark) with successive versions of a technology for depicting classroom interaction in an effort to translate a written case to a storyboard. This examination allows our field to learn about affordances of storyboard technology for the representation of teaching practice. *Depict* (a tool included in *LessonSketch*; [www.lessonsketch.org](http://www.lessonsketch.org)), allows users to upload and manipulate graphics and provides cartoon characters designed to create classroom visual meanings. Just as language has the words *student* and *teacher* to represent roles in a classroom, and other linguistic resources to describe how people feel (e.g., the student was *happy*), where they are (e.g., the student was *at the board*), or what they are doing (e.g., the student was *solving an equation*), *Depict*'s graphic language has resources to represent those meanings (e.g., see Figure 1).

Notably, if words report simultaneous happenings, the graphic medium allow us to show this simultaneity. Video can also do that, but it might also include other messages about the action that might be less relevant to convey (e.g., the style of clothes popular at the time the video was captured). In designing a semiotic system for representing classrooms, the developers of *Depict* wanted to make available graphic elements and software features that help communicate classroom meanings of particular relevance for the study of teaching practice. One important set of considerations has been the dimension Herbst et al. (2011) called *individuality*, or the extent to which the set of graphic resources enables distinguishing individual differences among classroom

participants and settings. In this regard, it is worth distinguishing between *enacted* individual differences (e.g., the possibility that one student would do or express something that others would not) and *enduring* individual differences (e.g., based on individual characteristics that recur across enactments, such as body size, race, class, or gender). While *Depict*'s character set (Figure 1) was originally conceptualized as a cast of characters with some resources to express enacted individual differences (e.g., facial expressions, body orientation), very few resources were originally provided for enduring individual differences (e.g., no affordances for body size, hairstyle, or skin color). *Depict*'s characters were nondescript characters whose role was to depict practice rather than individuals. In that context, Chazan and Herbst (2011) had described the affordances of the cartoon characters as comparable to variables in algebra and distinct from diagrams in geometry: As Laborde (2005) has noted, diagrams have the liability that they spatiographically assert properties that are not always theoretically necessary—e.g., a diagram of a rectangle will likely show two sides longer than the other two sides. Other properties of rectangles, however, are not only visible but also necessarily true (e.g., opposite sides are congruent). Students often latch onto spatiographical properties as they use diagrams to learn geometry. While video is like diagrams in geometry in that it enables the observation of ancillary events, Chazan and Herbst (2011) argued that *Depict*'s cartoon language is like the generic language of algebra in its capacity to make assertions about practice, as opposed to assertions about specific individuals. Yet they also thought of the graphic resources as a developing language that would progressively incorporate new semiotic systems to represent more aspects of practice. The extent to which considerations of race enter in the way teachers relate to students in practice offered an important opportunity to further explore the possibilities of phasing in new graphic resources to increase the representation of individuality.



**Figure 1.** A frame from a storyboard using Depict.

New resources have been recently added to *Depict*'s graphic language to allow representation of some enduring individual differences. The *complexion* system, operationalized by color wheels that enable the user to pick skin tones for characters, affords the user the ability to choose whether to use the default blue skin or to choose freely from the color wheels. We wondered whether this particular affordance supported the work of a teacher educator in representing a case that he wanted to bring to his PSTs, and the extent to which the depicted representation allows for alternative inquiries and narrative. We examine the use of *Depict* by comparing Clark's Case of Mya (see Chazan, et al., 2016, p. 1059) and a storyboard Clark constructed to represent the case. The comparison is of interest because the storyboard demanded more graphic resources than were prescribed in the text (e.g., things unsaid in the text needed to be depicted to visualize the classroom scene) although it was created after the written case; generating the possibility that alternative stories could emerge from the engagement of the readers with the media.

### The Case of Mya

The Case of Mya describes a dilemma faced by a middle school mathematics teacher, Scott Johnston, in his effort to provide a more rigorous and challenging mathematical learning environment for one of his students, Mya. Johnston was employed in a middle school and district where 8th graders were assigned to one of four mathematics courses (from lowest to highest level of rigor): Math 8, Pre-Algebra, Algebra, and Advanced Algebra. A potential byproduct of grouping students by performance is grouping students by race and social class: Racial and class gaps in performance have persisted throughout the history of mathematics education in the U.S. The Case of Mya acknowledges and incorporates these complexities. Scott Johnston commits his efforts to providing Mya, an African American female eighth grade student enrolled in one of his lower level mathematics classes, a more rigorous school mathematics experience. Based on Mya's social and intellectual performance in the course she is currently enrolled in, Scott takes on the work of enrolling her in a higher-level course.

Clark was also recruited as a fellow for a project that supported the creation of multimedia representations of practice for use in teacher education. He took on the challenge to represent the Case of Mya as a storyboard. He describes his challenge thus:

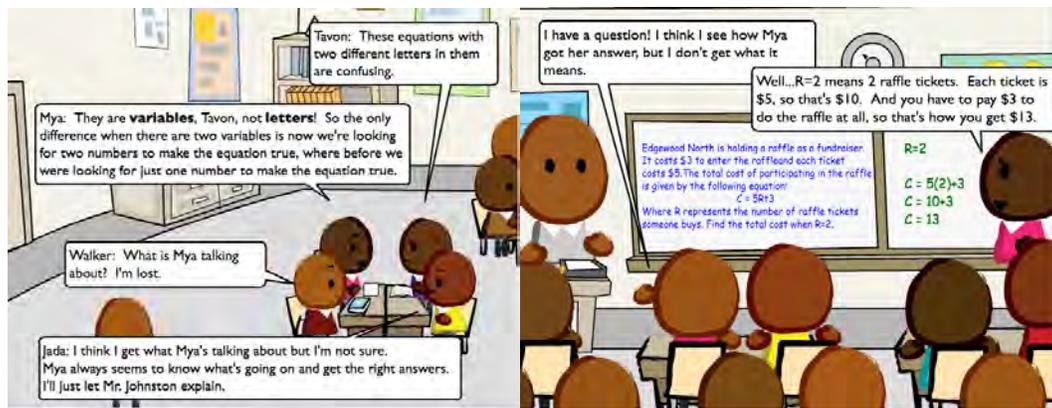
When faced with moving the written Case of Mya to a storyboard, numerous considerations came into play. The first consideration revolved around how I might illustrate the complexities of the case context. I grappled with questions like

- How can I depict the larger forces at play (context) that shape and direct a mathematics teacher's classroom decision-making and instructional practice?
- As race and class are 'in the mix' of students' access to mathematics opportunity, how can the storyboarding tools serve to illustrate these phenomena?

For example, in the written case, I had stated:

[S]he (Mya) was unquestionably the most engaged, inquisitive, and mathematically confident student in the entire [Pre-Algebra] class, and she consistently outperformed her classmates on tasks and assessments. She thrived in her position as one who I could call on to assist struggling students. Her ability to communicate her mathematical thinking and problem solving approaches in front of the entire class was unmatched. Mya fared less well in other academic areas, but it was evident to everyone, including herself, that she was comfortable and in her element when interacting in the [Pre-Algebra] class. (Chazan, Herbst, & Clark, 2016, p. 1059)

I had not gone into the specifics of her mathematical thinking in the written case. But I did go into specifics of her mathematical thinking when afforded the opportunity to create the storyboard. I designed the following scenes in the depiction and asked readers to explore and comment about Mya's mathematical thinking in the lower level class:



**Figure 2.** Mya's mathematical ideas, represented by speech and boardwork.

It was also important that both depictions of Scott and Mya reflect their African descent through skin tone, so I chose to depict Scott and Mya using dark skin tones. The written text of the Case of Mya explicitly refers to Mya as African American, however the text does not explicitly refer to Scott as African American, so the reader of the case may (or may not) see both Scott and Mya as African American. This shared racial characteristic can be explored in the discussion of the depiction to gauge the reader's perception of Scott and Mya's shared racial characteristic as relevant or salient to Scott's decisions. For some readers, Scott and Mya's shared racial characteristic may suggest some form of connection, allegiance, and loyalty. In the written case I described the Advanced Algebra class to which Mya transferred as being populated predominantly by Caucasian students. Identification of skin tones on the color wheel that represent Caucasian students was challenging. I tended to rely on pinkish or creamy skin tone shades. I had to create multiple pilot scenes to determine if pilot viewers saw the Advanced Algebra classroom as populated predominantly by Caucasian students. In some cases, viewers mentioned that the students in Advanced Algebra were unnaturally pink. Furthermore, when choosing pinkish or creamy tones for skin color, the color of the outline edge of the character created confusion in the viewer. For example, a light pink character possessed a dark pink edge. A creamy character possessed a brown or tan outline edge. During depiction design, I incorporated scenes of small group work in the Advanced Algebra class that showed Mya as the only student of color in the group. In these scenes, Mya's mathematical ability is questioned and challenged by others. The purpose of including these scenes is to further explore viewers' perspectives on whether race could be a salient and relevant influence on student-student interaction around the mathematics task at hand.

### Results and Discussion

From the above example, one may see affordances of a semiotic system embedded in the storyboarding environment. While building a storyboard the availability of the empty, but editable, whiteboard may make the creator wonder what should be written on the whiteboard in the case of Mya. It is more difficult to see those opportunities while writing a case. Similarly to the first example described earlier, from this second example one may generalize the affordances that a semiotic system could offer in the storyboarding environment. When creating a storyboard in *Depict*, the default skin tone of the students is blue (see Figure 1). One can change the skin tone of one character, but then it is likely that one will feel the need to assign skin tones to all characters. The teacher educator felt compelled to represent Scott's skin tone – which, as he suggests, might motivate a reader to infer social relationships between Mya and the teacher.

**Table 1.** Meanings attributed to the written and depicted case of Mya.

Excerpt from representation	Author meaning/intent	Reader/viewer interpretation (E) - expected; (U) - unexpected
<p>Written case: <i>Excerpts from written case transcribed above (p. 4)</i></p>	<p>Mya is successful when completing complex mathematics tasks and assessments in the pre-algebra classroom</p> <p>Mya has a strong mathematics identity in the Pre-Algebra course, yet may not possess a strong general academic identity (across all subjects).</p> <p>Unlike the majority of her peers in the Pre-Algebra class, Mya possesses confidence and comfort in communicating her mathematical thinking publicly.</p> <p>Mya may be viewed as a peer resource by other students.</p> <p>Mya’s explanations may support the development of other students’ understanding.</p>	<p>PSTs remarked that Mya possesses power and agency in the Pre-Algebra course. (E)</p> <p>PSTs remarked that Mya is a resource for other students in the Pre-Algebra course. (E)</p> <p>Some PSTs felt that the teacher should not move Mya from the Pre-Algebra course to the Advanced Algebra course. (U)</p>
<p>Depiction: See Figure 2</p>	<p>The Pre-Algebra class is composed predominantly of students of African descent as signified by student skintone; the Advanced Algebra class is composed predominantly of Caucasian students.</p> <p>Mya’s demonstrates an understanding of the concept of variable.</p> <p>Mya’s demonstrates the ability to solve equations in one variable and equations in two variables given a value for one of the variables.</p> <p>Mya may be able to reason through identifying a set of values of the two variables that solve the equation without being given one of the values.</p>	<p>PSTs focused on many classroom signifiers when describing differences between the two classrooms (seating arrangements, calculator use, etc.), yet were hesitant to mention racial differences between the two classes. (U)</p> <p>A PST interpreted Scott Johnston’s physical distance from students in the Pre-Algebra class as a classroom management strategy (‘he needs to be able to see all students at all times due to behavior problems’) (U)</p> <p>PSTs remarked that Mya understood that parallel lines have the same slope. (E)</p> <p>PSTs remarked that Mya would be able to solve equations in two variables only when given a value for one of the variables. (U)</p> <p>PSTs remarked that Mya would be able to solve systems of equations. (U)</p> <p>When asked how Mya is perceived by her peers, a PST remarked that her peers may view Mya as unrelatable, intimidating, and a ‘know it all’. (U)</p>

The case of Mya provides the grounds for a distinction in the kind of storytelling afforded by the storyboarding tool. While originally developed to represent practice, *Depict* also permits to tell character-centered stories that happen in practice; indeed, to some extent it uses the latter to flesh out the former, much in the way that specific diagrams can represent generic figures – diagrams convey important intuitions that help generate geometric theory, might scenes with cartoon characters do the same for teaching? By character-centered stories we refer to stories that are focused on the individualities of one or more characters and what happens to them as they go through episodes in their lives; this contrasts with environment-centered stories that are focused on what happens in specific places as different characters interact. The original design of *Depict* supported the representation of practice in classroom-centered stories. The storyboarding of the case of Mya challenged *Depict's* graphic language and required the development of a framework for us to examine character-centered stories.

### **The Framework**

We suggest that one can think of the signifiers in a representation of a character-centered story as developed in concentric spheres, each of which includes a stratum of graphical elements available to choose from in order to graphically communicate strata-specific meanings. The innermost sphere in such representations consists of signifiers associated to the characterization of the protagonist(s) of the story. These could include signifiers of physical, cognitive, or emotional individual traits. The second sphere consists of signifiers of the immediate context of the protagonist(s) at various points in the story--resources to represent relations to other characters or to the immediate physical environment. A third sphere consists of signifiers of the more general environment in which the whole story takes place. Earlier, we described and compared the author's textual and storyboard representation of the case of Mya in which Scott proposes that Mya be moved from the Pre-Algebra class to the Advanced Algebra class. In that story, the second sphere will consist of characteristics of those classrooms and the third sphere consists of characteristics of the school community. These different strata form the first dimension of the framework. We argue that the value of the first dimension of this framework is that it helps one organize the many signifiers in a (character-centered) representation of practice.

A second dimension includes consideration of whose meanings one is attending to. The value of the second dimension of this framework is that it encourages considering what meanings different people attribute to a representation, in particular those attributed by the author and by readers, which we suggest are the source of alternative inquiries and narratives. As suggested earlier, we argue that storyboards allow for more alternatives, as they include not only text, but also other communication modalities. A comparison of Clark's intended interpretations of various signifiers in the two representations of the case of Mya and those made by his PSTs is used as example. In some instances, PSTs interpretations were aligned with Clark's meaning or intent; in other instances PSTs generated interpretations that were unexpected (see Table 1). We focused here on signifiers in the innermost sphere of the representation, similar such tables could be used to consider and compare interpretations of the signifiers at each sphere of stratification.

### **Conclusion**

The multimodal resources in the comics medium permit creation of complex messages about classrooms that allow for inquiry and alternative narratives by different readers (Weiss, 2011). These alternative forms of representation also have liabilities. A main gleaning from this paper is that the graphics communicate as a system, both for the author and for the reader. The creation of materials for the study of teaching is not only a creative endeavor but also an analytic one that involves

composing with a language and examining the systems of choice with which that language is built. The *individuality* dimension (Herbst et al, 2011) in representations of teaching is one aspect in which this semiotic system can be built, and complexions is one subsystem that contains affordances both for focusing the message and for enabling inquiry.

Indeed while written cases can focus attention on important aspects of practice and video can immerse students in the complexity of practice, a graphics-based semiotic system can be used to scaffold this complexity, combining inquiry with direction. The case of Mya shows that the translation from written case to storyboard included the opportunity to show some interesting nuances in the visibility of race, all of which have a lot to do with mathematics education if we think of mathematics education as an institutionalized practice: Students are learning mathematics in classes and with other students with whom they have particular kinds of social relationships, they are being taught by teachers who could be their advocates or mentors, and these relationships are mediated by race as well as other factors.

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