

Bidirectional Analysis of Creative Processes: A Tool for Researchers

Alecia Marie Magnifico, University of New Hampshire, alecia.magnifico@unh.edu
Erica Rosenfeld Halverson, University of Wisconsin–Madison, erhalverson@education.wisc.edu
Christopher T. Cutler, Independent Software Developer, ctcutler@gmail.com
TJ Kalaitzidis, University of Wisconsin–Madison, kalaitzidis@wisc.edu

Abstract: Young peoples’ creative production combines such activities as analysis of existing forms and genres; participation in processes including drafting, journaling, and modeling; sustained work on a particular idea; and mentor critique. In our work with a variety of settings, we have found that young artists’ progress depends on their engagement in all of these tasks, and that analysis of this work depends on looking across and through these varied practices. While typical descriptive analyses of such processes move forward, we have found that moving bidirectionally—from final product backward and from initial idea forward—better helps us to understand participants’ learning. We use examples from two creative production contexts to describe a technological tool developed for *bidirectional artifact analysis* by outlining its features, affordances, and constraints.

Why Analyze Creative Process?

In recent years, new literacies research has begun to re-focus the meaning of “literacy” and “multi-literacies” (e.g. Cope & Kalantzis, 2009; Moje, Overby, Tysvaer, & Morris, 2008). Beyond the comprehension and production of texts, “being literate” in a particular content area has come to describe fluency in specific “constellations” (Steinkuehler, 2007) of practices, modes, and ways of knowing. By producing content, learners use medium-appropriate tools to create artifacts and develop metarepresentational competence, an understanding of what tools are useful for expressing which ideas (Halverson, 2013). These understandings of literacy have particular purchase in digital environments and creative arts education, where interactions are often shaped by the production and critique of artifacts for a responsive audience.

Reframing literacy and learning in terms of how students use tools to communicate ideas requires an emphasis on measuring the process *and* the products of learning (Halverson, 2012). As researchers in the learning sciences, we seek to understand and design learning environments that support these complex practices. In order to do so, we must construct methods that help researchers describe the processes of creative production and the creation of successful literacy artifacts. We need analytical lenses that take the complexities of creative works themselves—from online video to school essay to multimedia collage—as units of analysis and trace these works through creation, drafting, and revision. Thus, we need tools that enable such analyses.

Because these social, artifactual, and often multimodal processes extend over varying periods of time, it is difficult to capture them using existing methods and tools for qualitative analysis. While our prior work has focused on the development of tools for analyzing youth-made films (Halverson, Bass, & Woods, 2012), these tools do not generalize to creative processes more broadly, nor do they capture the *process* of creation. Rather, they afford final product analysis. Altogether, creative production combines such activities as engagement with existing genres, problems, or frameworks; participation in interlaced processes (drafting, journaling, modeling, etc); sustained work on a particular idea; and audience-based critique (Barrett, 2000; Soep, 2006). In our work with young artists, media, and settings, we have found that their progress depends on their participation in all of these tasks—as well as ongoing engagement with their audience(s) (Magnifico, 2010, 2012; Halverson, 2012). In other words, the analysis of creative process depends on not focusing on particular types or genres of work, as in discourse analysis or artifact analysis, but looking across and through varied practices.

We first developed methods for understanding creative production processes (Halverson & Magnifico, 2013). We now have developed a tool to look across and through full trajectories of art development. Using Javascript, HTML 5, SVG, and CSS technologies, we present an alpha version and examine its affordances for data analysis and sense-making. We need such a tool to document creative practices, examine the origins of particular ideas and critiques, and trace how artists take up these concepts (in future drafts or more broadly). This year’s ICLS theme, “Learning and Becoming in Practice” highlights learning trajectories over time: ways in which learners adopt certain kinds of practices and become certain kinds of people (e.g. Duncan & Hmelo-Silver, 2009). Our tool helps streamline the analysis, visualization, and representation of the learning involved in creative production. As a field, the learning sciences value theory-building and technological design around such questions, and we are eager to participate in such ongoing conversations and inquiry.

Here, we use examples from two creative production contexts—creative writing and mobile game design—to describe our tool for *bidirectional artifact analysis*. We outline its features and offer suggestions for using the tool in other research contexts that value the role of process in understanding learning.

Audience as Fundamental to Learning Through Production

Much of the original literature that developed and documented rhetorical (e.g. Ong, 1975) and cognitive (e.g. Bereiter & Scardamalia, 1987; Flower & Hayes, 1981) viewpoints on audience implicitly assumes that when writers write with an audience in mind, these imagined readers have a measurable effect on the writing. This assumption is rooted in ethnographic and expert-novice research on how writers think and how writers write, and has been documented repeatedly with different kinds of writers. Understandings of audience and collaboration have broadened, however, as new media have pushed writers and artists into spaces where they may create, read, and view “among the audience” (Lunsford & Ede, 2009). This shift can transform writers into speakers, readers into critics, and both into collaborators. Within online and face-to-face artistic communities, it is increasingly plausible to think of readers and viewers in terms of Ong’s (1975) “collectivity, acting... on one another and on the speaker [or writer, or artist] as members of an audience do” (p. 11).

Considering how feedback guides artistic process suggests that audiences for creative work may play both a cognitive role in artistic production, in that sharing work forces creators to consider readers, and a social one, in that creators define themselves as community members by the work that they share (Magnifico, 2010). If we extend the metaphor of literacy from producing text to creating artifacts using various multimodal tools for meaning making, we can apply the same insight about audience to creative processes in general. Audience is central to the learning of creative production, not an afterthought. As a result, analyses of creative production processes must include an understanding of audience feedback and interaction as a core part of tracing learning.

The Role of Representation in Creative Processes

diSessa (2004) argues that representation design is a creative endeavor, “a venue in which creative and artistic skills are at a higher than normal premium” (p. 300). Thus, observing creative production helps us understand the role of external representation in learning (e.g. Eisner, 2002). “Getting smart” in the context of producing art “means coming to know the potential of the materials in relation to the aims of a project or problem” (Eisner, 2002, p. 72). The capacity to build representations from different materials for multiple situations is a marker of creative expertise (Hayes, 1989), and has been called “essential in investigations of creativity” (p. 262) (Hasirci & Demirkan, 2007). Since creative production requires creative representation, young artists must learn to construct and evaluate multiple representations. We have called this process “the representational trajectory” and its outcome the development of “metarepresentational competence” (Halverson, 2013).

The representational trajectory describes how producers focus on a central idea or concept, use this idea to motivate the development of skills and tools to represent their concept, and design a product that reflects this relationship between concept and tools. To study and describe this learning process requires multiple forms of evidence at multiple points in time, often with the engagement of multiple peers and mentors (Halverson, 2013). Creative production settings often encourage novices to use several media to produce their art. While representations may shift and ideas may transform through drafting, feedback, and revision, understanding how these artifacts contribute to the final “text” is necessary to understand the processes that producers employ.

Bidirectional Artifact Analysis

To address this methodological need, we developed *bidirectional artifact analysis* (BAA), an analytic method for understanding creative production that employs ethnographic observations of participants, artifacts they create, and interviews over time (Halverson & Magnifico, 2013). A key component of BAA is this concept of time. Most education research moves forward in time because learning continually builds up from prior knowledge. Our concept of time is grounded in Enyedy’s (2005) description of bidirectionality: “go[ing] ‘backwards’ in time in an attempt to trace the origins of this intervention and ‘forwards’ in time to examine what subsequent impact it had on the way other students reasoned” (p. 437). Moving bidirectionally helps us understand the role of social, collaborative feedback and audiences in young peoples’ learning. By turning the analytical lens, we see *how* learners’ reflections on past representations become shared prior knowledge.

BAA involves three steps: 1) identifying learner-created artifacts; 2) documenting relevant data around artifacts; 3) constructing threads across the data types to trace the final product’s core ideas and tools back through their development. We have used this method to understand various forms of production in different contexts including school writing (Magnifico, 2012), online creative writing (Magnifico, 2013), extracurricular digital art-making (Halverson, 2012), and radio documentaries in a college class (Bass & Halverson, 2012).

While technology has played a large role in documenting and capturing relevant data, we have found that we need a technological solution to this complex methodological problem: How can we construct threads across data types that allow us to “see” backwards and forwards across time, as BAA requires? Since the threads may include artifact analysis, multimodal analysis, and discourse analysis, we needed a way to identify, track, and compare narrative and artifactual threads both within a process (or draft) and across processes (or drafts). To address these needs, we have built a tool that aims to solve this problem. In the following sections, we describe the key features of the tool, highlighting potential affordances, constraints, and uses.

The Development of a Bidirectional Artifact Analysis Tool

Technical Details

The tool that we are developing, currently code-named Cotswold, is a javascript program that runs in a web browser. It uses the D3.js data visualization library to render its internal model of artifacts, their attributes and their relationships. D3.js uses a functional (as opposed to imperative) approach in which data structures are bound to a document object model and the appropriate rendering of the model is described in general without requiring code that iterates over individual data elements. Cotswold uses D3.js to produce a series of HTML and SVG documents that, when layered on top of one another in the top level HTML document, render the artifacts with all of their relationships and attributes. Every time the user makes a change, Cotswold updates its internal model, serializes it to a JSON string and stores the JSON on the user's computer using HTML5's local storage feature. In this way, the program remains entirely client-side. It does not store the user's data on a server in the cloud and in fact does not require an internet connection to run—only a web browser.

Cotswold is being developed in Google Chrome. It should work in any standards-compliant web browser but, as it is a working prototype, it has not yet been thoroughly tested. Currently, it lacks many features required for ongoing usability, but is an effective tool for idea generation. We are developing a variety of features and we anticipate that a beta will be available for sharing and testing at ICLS in June, 2014.

Features and Case Examples

Having established the importance of thinking bidirectionally, we turn to the decisions that we made while designing Cotswold, as well as the key features that enable data analyses and theory development. In many ways, Cotswold replicates the tools that we have used before. Like spreadsheet or transcript analysis programs, it allows open-ended coding and annotation. Like paper and colored pencil, it enables flexible multimedia timeline building and connection drawing. At the same time, the tool offers the ability to build persistent, manipulable visualizations of the ways in which artistic concepts evolve through formal critique, social conversation, mentorship, reflection, and ongoing revision. While paper and spreadsheet constructions may require several levels of abstraction and modeling to capture, code, and understand artistic drafting and critique processes—particularly when multiple media are involved—this tool uses the natural logic of such situations and processes to map and annotate them visually.

In short, the features capture how producers look backwards and forwards across their work in order to critique and revise. As we continue to develop Cotswold and use it to analyze datasets from multiple creative spaces, we anticipate examining larger questions, as well. For instance: Do commonalities in process exist *across* these environments? Do certain kinds of questions and interactions inspire creators to revise and rethink? How might these patterns be useful in designing learning situations that better support creative development?

In this section, we describe three central features of the tool and discuss their affordances for process-centered, holistic data visualization and analysis. We then explore potential constraints of this approach and consider how ongoing tool development will contribute to our analytical techniques and theory development.

Example Data

In order to define and explain Cotswold's features, we have drawn small samples of data from two previous studies that illustrate the features, affordances, and constraints of this tool. All names are pseudonyms.

Melanie's Story

The creative writing data are drawn from Magnifico's 2010 study of an extracurricular writing camp where high school writers in an urban area of the Midwestern United States worked on creative writing, workshopped their writing with peers and local writers ("writing coaches"), and performed their works in a final "showcase reading." Data collected includes observational field notes, interviews with young writers and writing coaches, recordings of "writers' circle" critique sessions, participants' writing notebooks and their stories. Each day, the young writers wrote during "sacred writing time" and participated in writers' circles. Melanie's story, excerpted here, was typical in length (900-word final draft) and genre (realistic fiction). She wrote 4 drafts during camp, as well as a 750-word anthologized version that she read at the showcase. In writers' circle, Melanie explained that her story was inspired by her mother's reading of *The Nine* and their resulting dinner-table discussion of Justice O'Connor's retirement from the Supreme Court to care for her Alzheimer's-afflicted husband.

ARIS Design Memos

Data from the ARIS Game Design project are drawn from Halverson and Kalaitzidis's 2013 study of an undergraduate course entitled "Digital Media and Literacy." This course engaged students in digital media production processes including the design of an augmented reality mobile game using the ARIS platform (see <http://arisgames.org/> for details). Students created games over the course of 6 weeks; during this process, they wrote design memos at the end of every week regardless of the progress they had made. Kristina described her

game as a guided tour of her local city, “focused on calmness and the artistic inspiration that can come from an invested sense of place” (final design memo). In order to understand how undergraduate students developed metarepresentational competence, we collected and analyzed these weekly design memos as well as all the artifacts they created during the course of the ARIS project: paper prototypes and design cards, screenshots of back end coding, and screenshots of versions of their mobile games.

Feature 1 — New Analytical Metaphors: Timepoints and Trajectories

Feature Description

Cotswold’s organization creates a timeline metaphor for data analysis. Often, analytical frameworks rely on coding, sorting, and categorizing utterances or activities. In a classroom study, researchers might separately group and analyze all of the instances where teachers teach full-class lessons and instances where students work in small groups. Creative process work, however, must examine the multiple activities that comprise the production cycle (Halverson, 2012) of a particular piece—steps that go into the story of that piece’s creation.

In other words, for us to understand the *process* of creation and all of its expected (and unexpected) developments in settings like creative writing workshops (Magnifico, 2012) and youth media organizations (Halverson, Bass, & Woods, 2012), we must examine full narratives of creative production. We initially began this work by adapting tools such as spreadsheets, paper, and colored pencils to view these large progressions, but such models are unwieldy and not easily revise-able. Thus, we designed Cotswold to digitally group artistic activities by trajectory and process.

Affordances

Changing analytical metaphors allows researchers to organize collections of pedagogical activity, artifact production, and critique by *time* rather than by type or code. Building timeline-based collections allows us to organize how we see and analyze various points on the timeline, and to examine multiple transcripts of participants’ talk and drafts of media artifacts in the same space. For example, Melanie began her story with a short vignette. In writers’ circle, she noted that “I only got a paragraph done [in sacred writing time]... it’s not a very good paragraph.” She explained that she didn’t know where to start and read the paragraph that introduced her main character’s central dilemma: A husband who has been diagnosed with dementia and is beginning to develop severe symptoms. This draft (“Draft 1”) is the leftmost timepoint, marked in Figure 1 in light blue.

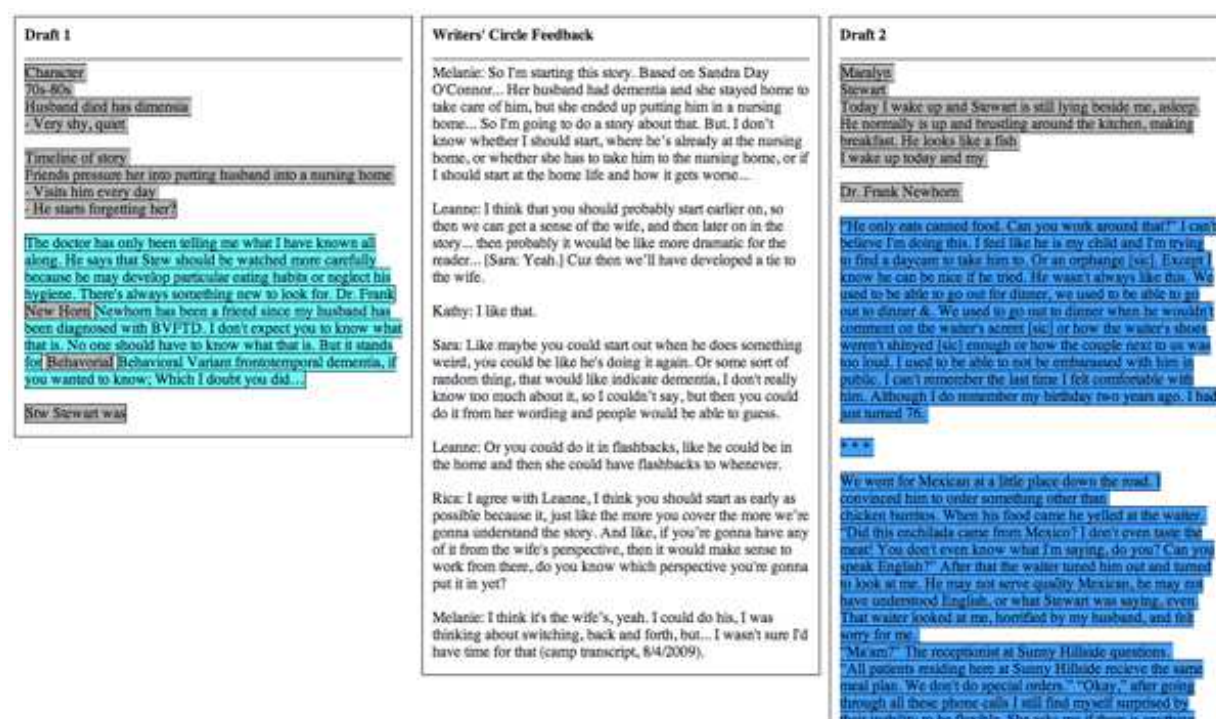


Figure 1: Timelines and timepoints place drafts in sequence and in context.

In the critique that followed (the middle timepoint, “Writers’ Circle Feedback”), the writers’ circle began to discuss what readers might need to know to understand the main character’s difficult domestic situation. Leanne initially suggested beginning the story earlier “so that we [the readers] can get a sense of the wife.” Sara furthered this suggestion by adding potential details, thinking about “start[ing] when he does something weird”

and pointing back to the text, where Melanie has discussed the husband's risk of developing symptoms like "peculiar eating habits." She considered how to pull readers in by helping them "guess" the storyline. Continuing her earlier suggestion, Leanne proposed a structure wherein Melanie might include flashbacks to "start earlier on" while maintaining a sense of the present. In the third "Draft 2" timepoint in Figure 1, marked in darker blue, Melanie reworked the opening to portray her main character speaking with an assisted living nurse, trying to place her husband in a supportive home. Later, the character flashes back to her first experiences of her husband's deteriorating condition.

At first, the two drafts look so different that it might be difficult to recognize them as drafts of the same story without the critique. The tool, however, allows researchers to mark and characterize differences between drafts; to view these artifacts in the context of creation, critique, and revision; and to visually represent changes across timepoints. Such time-based analytical structures make it possible to see the relationships among the artifacts and media that are constructed during creative production—a key to understanding these processes.

Feature 2 — Conceptual Coding: Multimedia Selection and Annotation

Feature Description

Working within the timeline metaphor, bidirectional artifact analysis relies on the in-context categorization of data such as transcripts of work sessions, critiques, and drafts of artifacts. While interpreting these data is similar to the general processes of qualitative research, the presence of multimedia artifacts complicates analyses. In response, Cotswold allows researchers to place textual and visual artifacts side by side in timelines and to annotate these elements to create codes, categories, and interpretations without separating this text from the overall context. (In future releases, we hope to incorporate video- and sound-based artifacts as well.)

Such annotation and interpretation is important because ideas, questions, and critiques often cycle through several drafts of a creative piece or across several members of a production environment. For example, in previous analyses, we have shown that asking an artist to consider the effect of a particular choice on readers or viewers—critiques that make audience involvement clear—often lead to revisions (Magnifico, 2012). Similarly, a particular motif may be introduced to a draft artifact after comments from readers or mentors. Because Cotswold can highlight words, phrases, and image fragments, as in Figure 2, it is easy to visually group such elements for analysis and write short memos about how such elements should be categorized. As codes and constructs are revised, it is possible to reorganize and rework the visual representation of these categories.

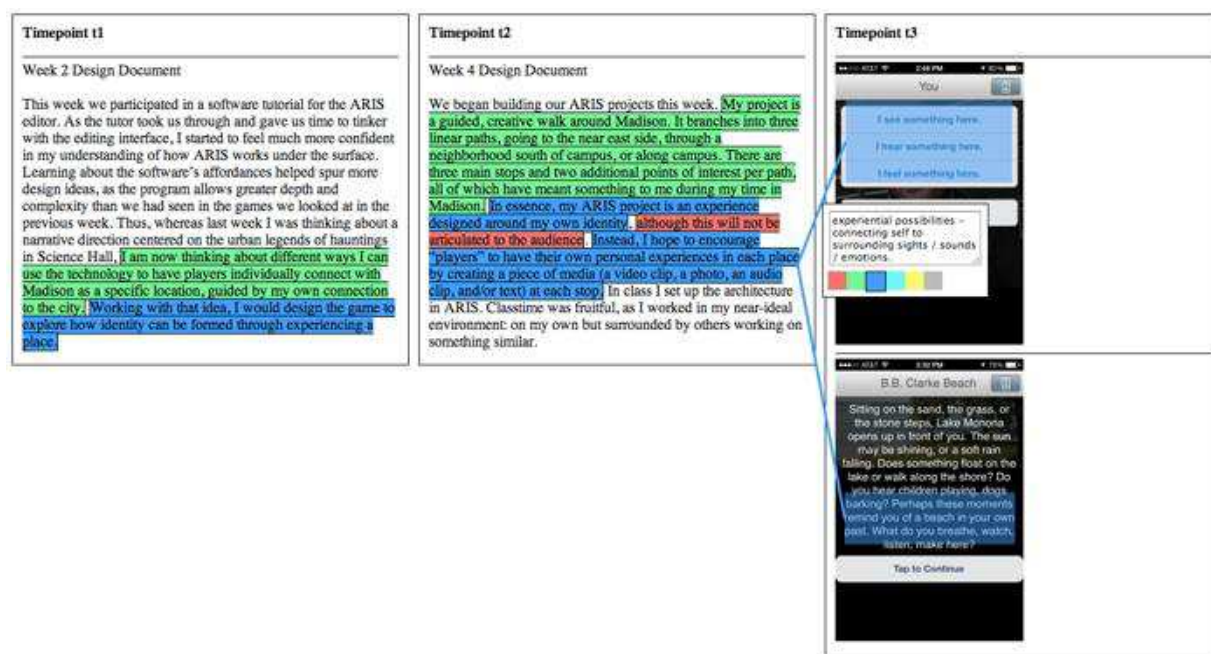


Figure 2: Highlighting and annotating talk and image side by side

Affordances

Regardless of whether such annotation captures micro or macro trends in the data, it occurs within the context of the timepoints and timeline so that researchers can perform artifact-based tracing without losing sight of broader narratives and trajectories of learning. Thus, the design of this feature affords a persistent visual, annotated instantiation of the revision and reflection that occur over a creative production cycle. Cotswold additionally allows this conceptual coding and annotation across multiple media. Researchers may place artifact

drafts next to transcripts of feedback and visually represent the threads of conversation connecting these timepoints. Such flexibility, shown in Figure 2, is useful for constructing timelines that capture creative production environments where young artists employ several media in their drafts. Such representations may reveal clear progressions of meaning even though the concepts look very different across media such as transcripts, sketches, and production prototypes.

Figure 2 shows Kristina's progress through the planning and development of an augmented-reality tour of her city, which figures prominently in the "development of her own identity." In the first two timepoints—design documents from Kristina's work on this tour—she considers her ideas about "how identity can be formed through experiencing a place" and describes wanting others to experience her city as she sees it. (Design Memo #2). In the textual Design Memos, she discusses the purpose of her game: A tool for players to capture (through photographs, video, or poetry) similar experiences and emotions. The two screenshots in timepoint three show how she translates these ideas to the screen in her ARIS game, which asks players if they "see, hear, or feel something here" and draws connections between her city's locations and similar locations "in your own past." Despite differences in narrative and image-based instances of such meanings, Cotswold allows researchers to link them through color (blue represents "identity" in Figure 2, and green represents "place") and drawn lines.

Feature 3 — Interpretation: Connecting Fragments

Feature Description

Cotswold's connection feature, shown in Figure 3, enables an interpretive phase of drawing connections and establishing threads of meaning across production activities. As previously noted, cycles in different creative environments might include such elements as sketching or drafting in multiple media, social conversation, reflection, critique, and performance. Once researchers have ordered the activities represented by the timeline and created coding categories to mark up the timepoints (using highlighting and annotation tools), they may interpret and trace artistic choices through artifacts and conversations. This feature allows researchers to connect fragments to each other (within and across timepoints) while remaining within the natural logic of creative drafting and production. It is also possible to note patterns, and annotate these connections for analysis and interpretation. Drawing interpretive connections and coding data in context enables researchers to perform detailed analyses while staying close to the process and the narrative of each creative piece.

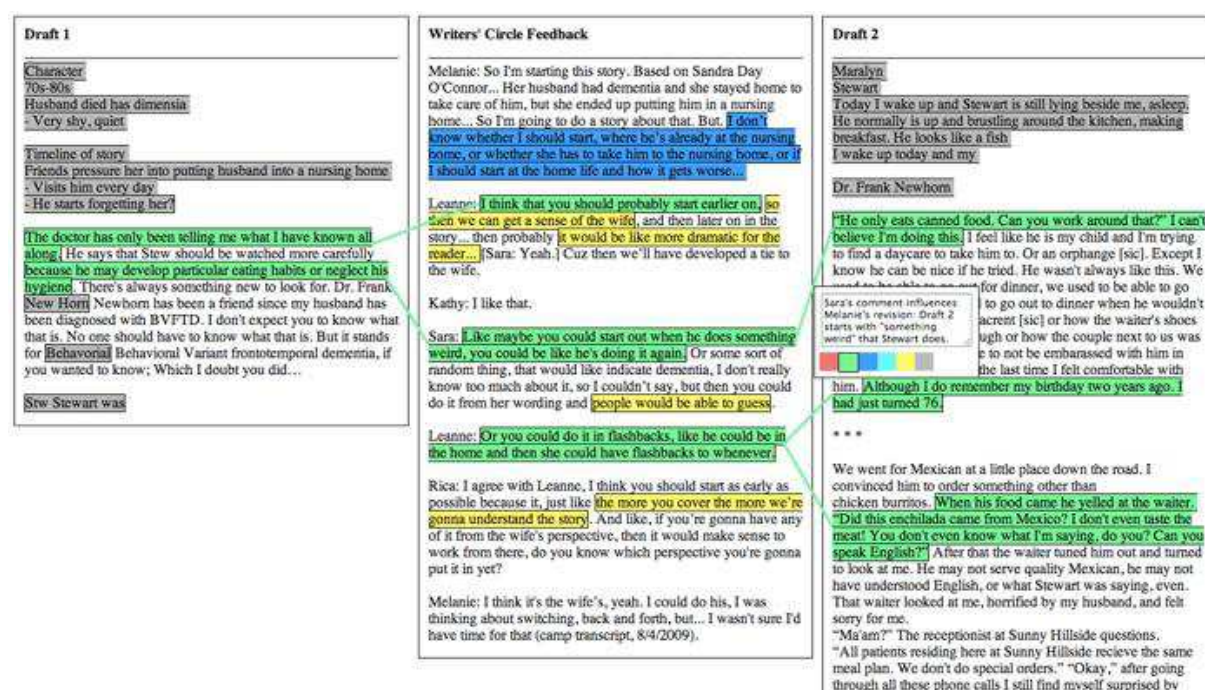


Figure 3: Tracing the development of story drafts through critique and connections

Affordances

In the course of creative production, critique often serves as ongoing, developmental conversation, so it makes sense for the tool to allow us to look backwards and forwards to annotate and connect key moments of insight without losing a sense of the overall context and activity. We return to the example from Melanie's story to show a different, more complex analysis of the relationships between her first draft, writers' circle critique, and second draft. As discussed above in Figure 1, Melanie revised her story almost completely between Draft 1

(timepoint 1) and Draft 2 (timepoint 3). In Figure 3, we examine how the feedback that Melanie received from her writers' circle centered on two concepts—structure and audience—that directed this significant revision.

The connection tool is useful here because it reveals how Melanie's revisions and additions are linked to the critique that she received in writers' circle. Without examining the critique transcript, however, it is difficult to understand why she revised as she did because her revision is so complete. As previously noted, Leanne, Sara, and Rica agreed that Melanie should revise her story's beginning scene to place her main character at the center of the story's action. Using the highlighting and connection tools, we traced the progression of two major concepts raised in this critique. In the middle timepoint of Figure 3, "Writers' Circle Feedback," Melanie first directs the critique (highlighted in blue) by requesting feedback on where the story's action should begin. Leanne suggests a structural revision to begin the action of the story "earlier on." This structural comment is highlighted green and connected to the Draft 1 text to show that "earlier on" means before the Alzheimer's diagnosis. Leanne looks back to Melanie's Draft 1 and discusses why a change is useful: If "we" "the readers" get to know the main character first, it will be "more dramatic" as her husband's behavior deteriorates and leads to this diagnosis.

Other members of the writers' circle reiterate this idea about structure and suggest possible revisions, such as adding flashbacks or clarifying the Alzheimer's diagnosis (all highlighted in green and annotated as structural suggestions in Figure 3). These critiques employ similar justifications for revision: Readers must make sense of the story and characters. These comments are yellow-highlighted and annotated as invocations of audience. In Draft 2, the rightmost timepoint, green highlights and connection lines interpret Melanie's adoption of these suggestions. Instead of beginning by "telling" readers the diagnosis, Draft 2 begins with a conversation between the main character and a nursing home aide and then propels the story back in time with a flashback.

Using Cotswold, researchers may highlight a range of related fragments and add connections between them. This interpretive analytical phase thus builds evidence for understanding revision motivations, as well as whether revisions are tied to particular critiques or pedagogical elements. Two fragments can only be connected to each other once, but any fragment can be connected to multiple other fragments. One piece of feedback may be the root of several revisions, as with Leanne's suggestion, and each of these can be linked to its root. As with selection and highlighting, researchers can use colored connections to code particular kinds of interpretations.

Constraints of this Approach

We have discussed the many affordances of using Cotswold for bidirectional artifact analysis—which represent, of course, reasons why we attempted the challenge of designing this tool. At the same time, this timeline-based and qualitative-coding-inspired view of creative process analysis constrains our sense of the data.

When we conceptualized BAA, we wanted to articulate "relationships between processes and products" and to examine "drafts as representations that grow and change as a result of individual cognitions, mentor responses, and social reflections" (Halverson & Magnifico, 2013, p. 406). By setting up timelines and marking artifacts and conversations as production timepoints, the tool forces researchers to examine data within its broad context and narrative arc. Writing about the patterns of a full production cycle, though, requires micro-examination of young artists' draft artifacts, critiques, reflections, and revisions. Cotswold is particularly useful in these fine-grained analyses, enabling us to see textual and imagistic changes and to trace them.

Constraints emerge because this analytical tool begins to dissect process in order to impose coded structures; it returns researchers to breaking creative production into pieces in order to document patterns. It is possible that looking for general patterns necessarily requires us to take such actions, but we cannot help but note that such decontextualization pushed us to develop a holistic view of creative process in the first place.

Conclusions and Implications

Understanding creative production processes is a complex endeavor that requires researchers to parse macro-level and micro-level data and, often, to combine data drawn from multiple media and creative activities. BAA offers a way forward by articulating a framework that combines methodologies for conducting inquiry with such qualitative datasets (Magnifico & Halverson, 2013), and Cotswold helps us track and document this inquiry without losing sight of the broader narratives and contexts in which learning occurs. While the tool currently enables the analysis of relatively small-scale textual and image-based datasets, we plan to expand these capabilities both in terms of scope and in terms of media range. As we continue to develop these methods and use the tool to analyze creative spaces, we anticipate examining larger questions, as well. We are particularly interested in learning whether creative processes seem to exist *across* these environments and how these patterns could potentially be useful in designing learning situations to support creative development.

We believe that BAA, and Cotswold as a tool for such analysis, has particular relevance to the learning sciences because of the field's interest in considering learners' individual content knowledge, their adoption of certain kinds of practices, and their becoming certain kinds of people as a result of their engagement in designed environments or problems. Many studies have established that using tools and making artifacts are key components of knowledge (Halverson, 2012; diSessa, 2004; Eisner, 2002). This framework and tool, in effect,

helps researchers to map and document the learning progressions in which young people participate in situ (cf. Duncan & Hmelo-Silver, 2009). We focus on artistic and creative production in our own work, but there are strong cross-content implications for this analytical approach. When we conceptualize learning as the development of representational competence that may be measured through individual cognitions, mentor responses, and social reflections (Halverson, 2013), bidirectional analysis becomes a possibility for understanding students' learning through experience and artifact, as well as contributing to ongoing curriculum alignment, assessments, and standards.

References

- Barrett, T. (2000). Studio critiques of student art: As they are, as they could be with mentoring. *Theory Into Practice*, 39, 29–35.
- Bass, M.B. & Halverson, E.R. (2012). Representation radio: Digital art-making as transformative practice in the college classroom. *Pedagogies: An International Journal*, 7(4), 347–363.
- Bereiter, C. & Scardamalia, M. (1987). *The psychology of written composition*. Hillsdale, NJ: Erlbaum.
- Cope, B., & Kalantzis, M. (2009). 'Multiliteracies': New literacies, new learning. *Pedagogies: An International Journal* 4, 164–195.
- diSessa, A. (2004). Metarepresentational competence: Native competence and targets for instruction. *Cognition & Instruction*, 22(3), 293–331.
- Duncan, R.G. & Hmelo-Silver, C. (2009). Learning progressions: Aligning curriculum, instruction, and assessment. *Journal of Research in Science Teaching*, 46(6), 606–609.
- Eisner, E. (2002). *The arts and the creation of mind*. New Haven, CT: Yale University Press.
- Enyedy, N. (2005). Inventing mapping: Creating cultural forms to solve collective problems. *Cognition & Instruction*, 23(4), 427–466.
- Flower, L. & Hayes, J. R. (1981). A cognitive process theory of writing. *College Composition & Communication*, 32(4), 365–387.
- Halverson, E.R. (2013). Digital art making as a representational process. *Journal of the Learning Sciences*, 22(1), 121–162.
- Halverson, E.R. (2012). Participatory media spaces: A design perspective on learning with media and technology in the 21st century. In C. Steinkuehler & K. Squire (Eds). *Games, Learning, & Society: Learning and Meaning in the Digital Age*. New York: Cambridge University Press.
- Halverson, E.R., Bass, M. & Woods, D. (2012). The process of creation: A novel methodology for analyzing multimodal data. *The Qualitative Report*, 17, 1–27.
- Halverson, E.R. & Magnifico, A.M. (2013). Bidirectional artifact analysis: A method for analyzing digitally-mediated creative processes. In R. Luckin, S. Puntambekar, P. Goodyear, B. Grabowski, J. Underwood, & N. Winters (Eds.), *Handbook of Design in Educational Technology* (p. 406–416). New York: Routledge.
- Hasirci, D. & Demirkan, H. (2007). Understanding the effects of cognition in creative decision making: A creativity model for enhancing the design studio process. *Creativity Research Journal*, 19(2–3), 259–271.
- Hayes, J. R. (1989). Cognitive processes in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity*. New York: Plenum.
- Lunsford, A.A. & Ede, L. (2009). Among the audience: On audience in an age of new literacies. In M.E. Weiser, B.M. Fehler, & A.M. Gonzales (Eds.) *Engaging audience: Writing in an age of new literacies*. (pp. 42–69).
- Magnifico, A.M. (2012). Audience effects: A bidirectional artifact analysis of adolescents' creative writing. In J. van Aalst, K. Thompson, M. J. Jacobson & P. Reimann (Eds.), *The Future of Learning: Proceedings of the 10th International Conference of the Learning Sciences (ICLS 2012)* (Vol. 2, pp. 411–415). Sydney, NSW, Australia: International Society of the Learning Sciences.
- Magnifico, A.M. (2010). Writing for whom: Cognition, motivation, and a writer's audience. *Educational Psychologist*, 45(3), 167–184.
- Moje, E. B., Overby, M., Tysvaer, N. & Morris, K. (2008). The complex world of adolescent literacy: Myths, motivations, and mysteries. *Harvard Educational Review* 78(1), 107–154.
- Ong, W. (1975). The writer's audience is always a fiction. *PMLA*, 90(1), 9–21.
- Soep, E. (2006). Critique: Assessment and the production of learning. *Teachers College Record*, 108(4), 748–777.
- Steinkuehler, C. (2007). Massively multiplayer online gaming as a constellation of literacy practices. *E-learning and Digital Media*, 4(3), 297–318.