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Examining how different modes mediate adolescents' interactions during their collaborative multimodal composing processes

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ABSTRACT

Previous research illustrates the collaborative nature of adolescents' multimodal composing processes. However, few studies have specifically focused on how different modes influence student interactions over time. This study examines how multiple modes (e.g. text, music, visuals, and animations) mediated middle schoolers' composing processes as they worked in small groups to create multimodal science fictions. Situated in an afterschool program, each student selected the role of writer, scientist, or designer. Data sources included screen capture video, semi-structured interviews, and multimodal products. Qualitative data analysis involved the constant comparative method to establish codes for types of interactions and the mediating modes as a case study small group collaboratively composed. Findings indicate: (1) students were inclined to provide short responses to move on with composing practices; (2) group discussions while multimodal composing followed three stages: mode and story exploration, mode-story integration, and mode-story completion; (3) multimodal comics fostered the most discussion; (4) different modes supported self-oriented and group-oriented contributions in unique ways. This study contributes an initial understanding into how different modalities mediate students' interactions and offers implications for scaffolding peer interactions during multimodal composing processes.

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Multimodal composing; peer interaction; social semiotics; mediation; collaboration

Introduction

Considering the changing literacy landscape, a growing body of research has examined adolescents' multimodal composing processes, including their designs (Dalton et al., 2015), use of digital tools (Smith, 2017; Takayoshi & Seife, 2007), and identity development (Vasudevan, Schultz, & Bateman, 2010). Recent research has also revealed how multimodal composing is a highly collaborative process for adolescents (Beach & O'Brien, 2015; Burnett, 2016; Ito et al., 2010; Jocius, 2018). These studies demonstrate how students work together on a wide range of multimodal projects (e.g. digital videos, podcasts, webpages) and at all stages of the composing process – including brainstorming ideas, composing with digital tools, editing, and presenting final products (Bruce, 2009). Students build upon each other's strengths and often learn new technical and design skills from their peers while multimodal composing (Beach & O'Brien, 2015). Research illustrates how students often individually tackle a piece of their project – based on technical skill, interests, or specific modes (e.g. sound, visuals, or text) – and then collaborate to integrate their contribution within the shared composition (Ryberg, 2007; Smith, 2019; Wikan, Mølster, Faugli, & Hope, 2010).

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Within the research on collaborative multimodal composing, a handful of studies have examined how student interactions mediate their collaborative multimodal composing processes. This research underscores how students exchange and evaluate ideas while composing (Bruce, 2009; Jocius, 2018). For example, Wikan et al. (2010) explained how group-based multimodal composing provided rich interactional opportunities where students collaboratively created, shared, and explained the nuances of their digital products. Suthers and Hundhausen (2002) revealed how different multimodal artifacts could impact students' verbal elaborations of their emerging knowledge while investigating a complex public health problem. Alternatively, Metatla, Bryan-Kinns, Stockman, and Martin (2012) demonstrated how students sometimes worked in parallel on two independent composing actions instead of waiting for partners to finish their part of a multimodal project.

Although important strides have been made in understanding adolescents' collaborative multimodal composing processes, much more research is needed that explores the specific nature of students' interactions and how collaborations are mediated by different modalities. This close examination of the role of multiple modes for shaping collaborations is needed to "best support the co-construction of meaning and negotiation of ideas" in learning contexts (Jocius, 2018, p. 15).

To address this need, we closely examined how a small group of middle school students interacted with each other while creating a multimodal science fiction during an afterschool program. In particular, this study was guided by the following research questions:

- What were the patterns of interactions when a small group of adolescents composed with multiple modes in a digital environment?
- How did peer discussions centered on different modes (e.g. texts, music, and images) develop and/or change over time?
- How did different modes mediate different types of peer interactions?

Through a fine-grained analysis of students' interactions while multimodal composing, this study offers new insights into the role of multiple modalities for mediating collaboration.

Theoretical framework

We draw upon a sociocultural perspective of mediated action in which learners construct meaning while they employ cultural tools and dialogically interact (Vygotsky, 1980; Wertsch, 1994). When applied to multimodal composing, mediational means can include technical tools and modes (e.g. texts, visuals, sounds, and movement) that are integral to facilitate the joint production of multimodal artifacts. Additionally, this perspective provides insights into how mediational means "constrain as well as enable action" (Wertsch, 1998, p. 33). While Vygotsky's (1980) works focused primarily on the mediational role of signs, Rogoff (1990) stressed the social contexts that mediate students' learning. Of major interest here is to understand how learners respond to and build upon peers' contribution through different modes in knowledge construction (Weinberger & Fischer, 2006).

This study was also located within the social semiotics theory (Hodge & Kress, 1988; Kress, 2010), which elucidates the ways in which people use a variety of modes to construct and exchange meaning. Composers leverage the semiotic resources imbued in modes to represent their understanding of the world and to forge relations with others (Jewitt, 2008). Research utilizing a social semiotics perspectives opens the door to understanding modal affordances (Kress, 2010), which "refer to what it is possible to express and represent easily with a mode" (Jewitt & Henriksen, 2016, p. 218). These modal affordances are based on its social history, cultural uses, and material features (Kress, 2010). An integrated social semiotics and mediated action perspective provides a needed lens for investigating the affordances different modes have for shaping interactions between peers while constructing knowledge in specific learning contexts.

Multimodal research often emphasizes the affordances of composing with multiple modes for fostering engagement, collaboration, and identity development (e.g. Ito et al., 2010; Vasudevan et al.,

2010). However, little research has examined the specific and unique potentials of specific modes for fostering interactions and generating knowledge between composers.

Methods

Program design and implementation

This study was situated in an afterschool program developed to improve adolescents' competencies in integrated STEM and digital literacy practices. Specifically, the learning goals of the program were: (1) facilitating students' disciplinary identity development through role taking; (2) increasing students' participation in integrated STEM practices through multimodal composition; (3) engaging students in collaborative knowledge building with a common science theme, environment and human health.

The afterschool program was hosted at a university in a large Southeastern city in the United States. Participating students who were interested in the program goals were recruited on a "first-come, first-served" basis. A total of 18 students initially enrolled; however, 9 students remained and contributed substantially to their team projects throughout the program. Among the nine students, there were two females and seven males who ranged in grade levels (two fifth graders, two sixth graders, four seventh graders, and one eighth grader).

The program centered on students collaboratively creating multimodal science fictions that integrated multiple modes (text, visuals, sound, and animation) and digital formats (e.g. hyperlinked text, Scratch animations, Pixton comics, infographics) into an interactive flipbook. The project challenged students to choose a relevant socioscientific issue (e.g. climate change) and creatively develop solutions for it through their science fiction narrative. Each student self-selected one of the following roles: writers (developing story narrative), scientists (integrating science ideas), and designers (creating visual and audio artifacts). Despite these differentiated roles, team members were encouraged to collaborate with each other on their individual and collective tasks.

Participating students met every Saturday (2.5 hours each session) for 10 consecutive weeks. Students took an interest survey polling their preferences in the roles at the end of the first session and formed groups of three based on role preferences at the beginning of the second session. Then, students worked in their small groups to develop multimodal science fictions while the research team provided individual feedback to each student from the second to the ninth session.

As participant observers (Spradley, 1980), we designed the curriculum and led different aspects of the workshop while other research team members collected data. Most sessions were organized into three main instructional sections (Smith & Shen, 2017). The first section of each workshop included a team member or guest speakers who presented on a range of related topics, such as science fiction writing, frontier scientific research, and multimodal design. In the second section, we provided explicit technology mini-lessons for using various tools. Students learned how to use Bitstrips[1] for creating comics and Scratch for creating animations. All students used iKOS (ikos.miami.edu), a digital composing platform developed by the third author, for creating their multimodal science fictions and corresponding knowledge entries (e.g. to illustrate a science concept in the fiction). Finally, the third section of each workshop was self-directed work time for students to collaborate on their science fiction project.

Students were asked to frequently share their in-process work to team members and the whole group. At the end of the program, students presented their work at an international science fiction film festival held in the same city.

Data collection

Multiple data sources were collected to explore students' collaborative multimodal composing processes:

- *Computer screen recordings*. Both students' computer activities and conversations were captured by Camtasia, a screen-recording software program, and saved as digital videos.
- *Semi-structured interviews*. At the end of the project, we conducted 30-minute semi-structured interviews (Patton, 1990) with students individually. The purpose of the interview was to learn more about students' perspectives on their designs and collaborative multimodal composing processes.
- *Artifacts*. We collected any process work associated with the final multimodal science fiction project. Figure 1 shows examples of students' artifacts, including science fiction chapters in iKOS and comics in Bitstrips.

Data analysis

We analyzed screen recordings of student-directed interactions during small-group work time, semi-structured interviews, and multimodal artifacts to understand how multiple modes mediate peer interaction. We also applied content analysis (Kohlbacher, 2006) for a case study (Stake, 1995) of a small group of students who wrote the multimodal fiction, "Research Gone Wrong." The group included three members. Camila (all names are pseudonyms), a Latina student (sixth grader), was passionate about writing and immediately selected the role of writer. Luka, a Latino student (seventh grader), was excited to take the role of designer to express his creativity. Alonzo, an African American male (seventh grader), reluctantly chose the role of scientist in order to stay with Luka, who attended the same school as him. In terms of their experiences with technology, both Camila and Luka were confident creating artifacts with a variety of digital tools while Alonzo had less experience with technology.

Analytic steps

The sequence of detailed analysis steps was not predetermined but rather emerged inductively through our interaction with the data and literature (Strauss & Corbin, 1994). First, we transcribed screen-recording videos of small group work. Next, the research team employed open coding (Charmaz & Belgrave, 2006) when reviewing transcripts, video data, and multimodal products to develop an initial coding scheme that captured how students interacted through different modalities. In reviewing the literature, we adopted Weinberger and Fischer's (2006) framework in coding types of discursive interaction while codes for types of modes mentioned in the interaction emerged from the data. Weinberger and Fischer (2006) posited five dimensions of co-construction: externalization, elicitation, quick consensus building, integration-oriented consensus building, and conflict-oriented consensus building. This framework delineates "to what extent learners refer to the contributions of their learning partners" (Weinberger & Fischer, 2006, p. 77) and has been

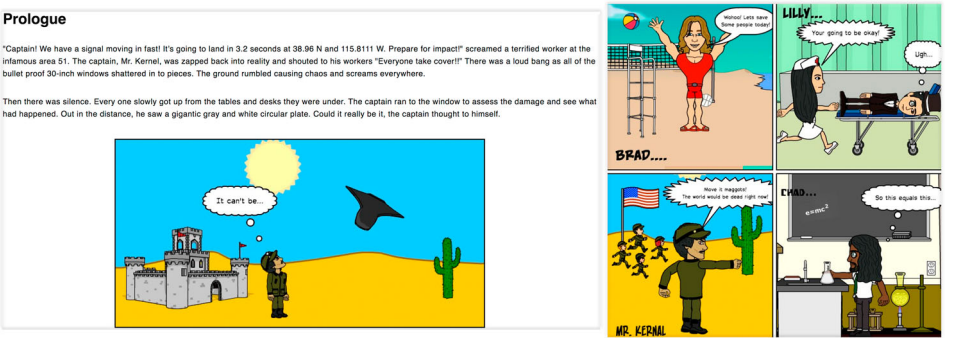


Figure 1. Multimodal artifacts created by students, including science fiction chapters (left) and Bitstrips comics (right).

employed by a large number of studies to examine discursive interactions (e.g. De Wever, Schellens, Valcke, & Van Keer, 2006). Finally, the coding scheme was refined based on collaborative research group meetings. Once the codes could describe all data satisfactorily, we coded transcripts using the final scheme.

The final coding scheme, summarized in Tables 1 and 2, includes two dimensions for each unit of analysis: types of interaction students used (e.g. sharing ideas, asking questions, giving commands, providing short, or elaborated feedback) and modes they referred to (e.g. animations, texts, images, music, multimodal comics, or other). Each unit of analysis is an interactional segment, referring to an episode whose boundaries are determined by changes in topics of discussion or speakers (Chi, 1997; De Wever et al., 2006). Changes in any of the two dimensions or changes in the student who spoke would lead to a change of unit of analysis. Tables 1 and 2 describe codes for interaction types and modes respectively. In Table 1, the first three codes are self-oriented contribution (operating on the speaker's own contribution), while the rest two codes are group-oriented contribution (responding to others' contribution) (Teasley, 1997). In Table 2, multimodal products can be composed of more than two modes: multimodal comics might include both images and texts. Finally, two of the authors double-coded the data and the inter-reliability of interaction types and modes were 83% and 89% agreements respectively.

To answer the first research question regarding patterns of interactions, we examined frequencies and percentages of each type of peer interaction while students composed. These measures contribute to an in-depth understanding of patterns of interaction in qualitative studies (Maxwell, 2010). We also utilized discourse visualizations to show the number of interactional segments per minute for different types of interactions. To address the second research question of how discussions on different modes change over time, the interaction density (i.e. number of segments per minute) of modes in each session was analyzed. To understand the third research question on how different modalities mediated different peer interactions, we calculated the percentage of each interaction type for different modalities.

Table 1. Codes of interaction types.

Interaction type	Definition	Example
Share	Providing ideas without reference to contributions of partners	Student: "We should make a scratch animation and in the animation, Brad was running."
Question	Asking questions	Student: "Should we make Brad cozy, at the beginning, and a good guy at the end?"
Command	Giving of verbal commands or orders to partners	Student: "You need to spellcheck this."
Quick responses	Responding to contributions of partners to move on with the task	Student (responding to the partner's idea of plot development): "That's great!"
Elaborated responses	Responding to contributions of partners by integrating perspectives of partners	Student (responding to the partner's question of "Why we have a pharmacy in the comic?"): "Because supermarket has pharmacy and that's where they will make medicine."

Table 2. Codes of modes.

Mode	Definition	Example of group discussions
Animation	A dynamic visual artifact	Student: "We can make a *scratch game*."
Text	A textual artifact	Student: How is *the story writing* so far?
Image	A static visual artifact	Student: Could you look up *images of Delak*?
Music	An auditory artifact	Student: that's not *the song from Adele*.
Multimodal comic	A multimodal artifact that includes a mixture of visuals and texts and are composed in deliberate sequences	Student: why *the comic* should be in a pharmacy?
Other	No specific artifact was mentioned	Student: Yeah.

The dominant patterns and themes that emerged from content analysis were triangulated with other data sources. Specifically, we constantly compared (Strauss & Corbin, 1994) the results of the video analysis and semi-structured interviews to deepen our understanding of the case study group's interactions during multimodal composing processes. Along with triangulating different data sources, we sought to strengthen trustworthiness (Erlandson, Harris, Skipper, & Allen, 1993) by actively seeking disconfirming evidence. Analysis was an iterative process that involved the research team discussing and challenging our interpretations.

Findings

Camila, Luka, and Alonzo created a multimodal science fiction that included 3569 words, 9 comics, 1 image, and 1 music clip. Their story centered on three strangers – Lily (a nurse), Brad (a lifeguard), and Chad (a scientist) – who met while escaping from zombie-like human beings who were infected by mysterious bacteria. Lily and Brad decided to help the scientist, Chad, find a cure to relapse the zombies back into normal humans. While creating their multimodal science fiction, the group wrote chapters of their narrative, hyperlinked to other media, searched for pictures and music online, and designed comics in Bitstrips. In the following, we describe findings focused on each of the three research questions.

RQ1: What were the patterns of interactions when a small group of adolescents composed with multiple modes in a digital environment?

Distribution of types of peer interaction during collaborative digital multimodal composing: quick-response strategy to expedite composing practices

Overall, students were more likely to share ideas and ask questions, and they tended to use quick-response strategies while multimodal composing. Table 3 lists the frequencies and percentages of each type of peer interaction. In total, there were 1142 interactional segments of peer discourse. In terms of self-oriented contributions (i.e. operating on the speaker's own contribution), students often asked questions (26%) and shared ideas with partners (23%), but rarely gave commands (3%). This finding indicates that the group was open to share ideas and seek support from partners while composing. In terms of group-oriented contributions (i.e. responding to others' contribution), providing quick responses (34%) was far more frequent than providing elaborated responses (14%). This finding suggests that students tended to use a quick-response strategy where they provided short responses to partners seeking feedback as a means to efficiently move along their projects.

Students' interview responses also suggested that providing short responses was a typical strategy during multimodal composing. While answering the question, "what did collaborations look like in your team?" Camila explained, "if we had an idea, we would tell the other person so they can say yes or no and we would put it in the story." When responding to the same question, Luka mentioned, "Camila would be like 'what if this would happen and this would happen?' and we would agree to

Table 3. Frequency and percentage of each type of peer interaction.

Interaction type	Frequency (percentage)
Self-oriented contribution	
Share	261 (23%)
Question	298 (26%)
Command	31 (3%)
Group-oriented contribution	
Quick responses	386 (34%)
Elaborated responses	166 (14%)
Total	1142 (100%)

that." The quick-response strategy allowed for students to stay focused on their individual tasks while also simultaneously engaging with each other's work.

Group discussions while multimodal composing followed three broad stages: mode and story exploration, mode-story integration, and mode-story completion

When examining interactions across sessions, the group was more engaged in discussions at the beginning and the end of the project while fewer interactions occurred during the middle of their composing process. The curve of interaction density, which indicates number of interactional segments per minute for all interaction types, is displayed in Figure 2. The U-shape curve demonstrates that the group discussion fell into three broad stages: (1) mode and story exploration stage (sessions 2–4), (2) mode-story integration stage (sessions 5–7), and (3) mode-story completion stage (sessions 8–10).

Giving commands occurred much less frequently than other interaction types (Figure 3). Thus, while explaining the three stages, we focused on the interaction types of *share*, *question*, *quick responses*, and *elaborated responses*.

Stage 1: Mode and story exploration stage (sessions 2–4). In this stage, asking questions and providing quick responses dominated peer interactions. As shown in Figure 3, interaction density in *question* (e.g. "Have you mentioned supermarket in your story?") and *quick responses* (e.g. "Yes, they are") was much greater than *share* (e.g. "We need a song to end the story") and *elaborated responses* (e.g. "Don't add the video because it takes too long to get our point across"). Thus, students asked questions frequently and there were quick responses following these questions.

During this initial stage, students were inclined to explore either modes or story elements instead of linking these two elements. For example, in session 3, Camila proposed, "we can make a video game and put a movie inside. It might be hard, but we can split the work." In this example, she shared idea about including specific modes without referring to story content. As an example of talking about story without mode, in session 2 Luka said, "I have an idea. Instead of bacteria, what if it is in a secret research community and the animals mutated and attacked humans."

Stage 2: Mode-story integration stage (sessions 5–7). The second stage of students' multimodal composing processes involved an almost equal distribution of interaction types. This pattern

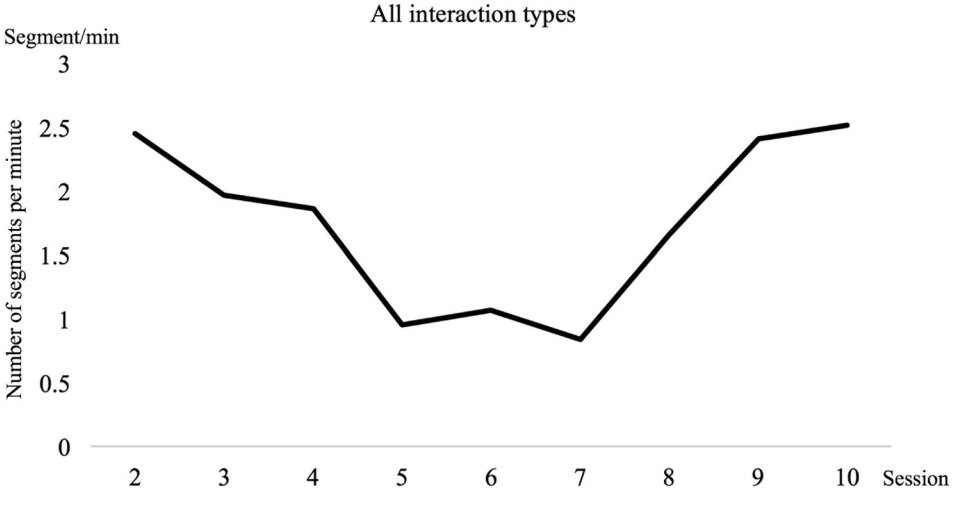


Figure 2. Interaction density (number of interactional segments per minute) of all interaction types across sessions.

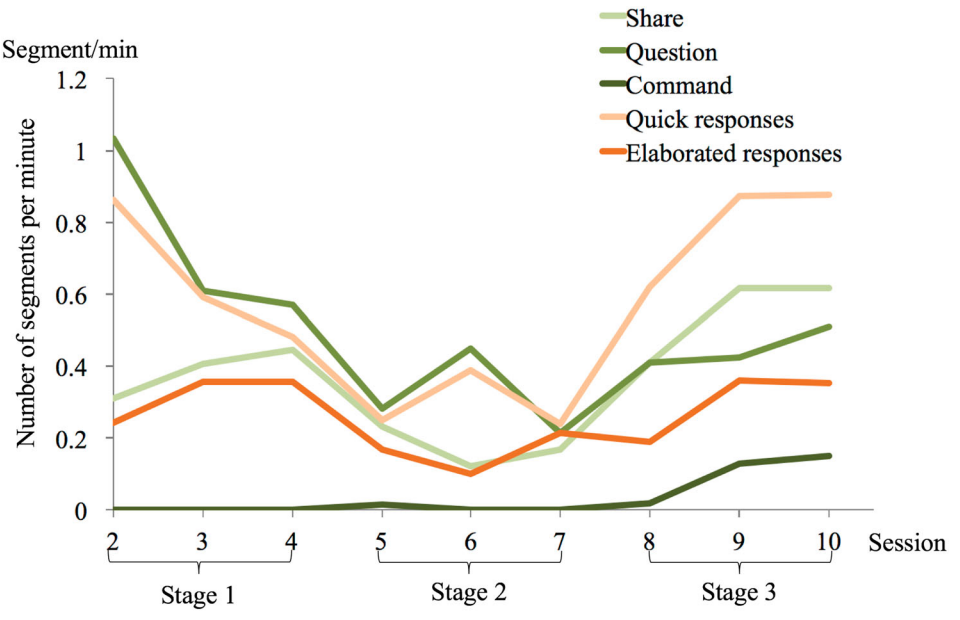


Figure 3. Interaction density of each type of interaction across sessions.

indicates that the group became accustomed to sharing ideas and providing elaborated feedback while building the story and learning tools to create their multimodal science fiction.

Different from stage 1, students were more likely to share or seek information for the sake of integrating modes with story content in the second stage. For instance, in session 6, Camila wrote the scene when Lily and her father reunited. At the same time, Luka played "Hello" (a pop song by an English singer Adele), and Camila proposed to her group, "If we can cut off the song when it plays 'hello, it's me.' It would be really a good fit for the moment when Lily met her father." Here, Camila related the lyrics in the song with her written narrative. Examples like this suggest that she understood both modes of representation, as well as how they could be linked in the science fiction.

Stage 3: Mode-story completion stage (sessions 8–10). In the final stage, providing short responses occurred most frequently. As shown in Figure 3, the interaction density in *quick responses* (e.g. "Yes, they are") was much larger than all the other interaction types. This pattern implies that students responded to others' sharing ideas or asking questions through statements affirming the validity of others' contributions. For example, during session 10, it was evident that both Camila and Luka were engaged in making sure that their contributions fit together while completing the story:

Camila	[Since I have finished all of the chapters] I am going to add hyperlinks for all chapters.
Luka	Ok.
Camila	Chapter 3 … How should I do it [link chapters]?
Luka	I am going to finish up the ending comic of the story.
Camila	Great.
(37 seconds later)	
Camila	You get a link and then … Should it like, in chapter 3, there are two hyperlinks: one for chapter 2 and the other one for chapter 4?
Luka	Yeah.

As shown in the dialogue, Camila connected all chapters with hyperlinks while Luka worked on the final comic. With the pressure of time, both students gave each other short responses to move on and finish the project while they concurrently completed their individual tasks.

RQ2: How did peer discussions centered on different modes (e.g. texts, music, and images) develop and/or change over time?

Comics dominated group discussions

Students discussed more often about comics that combined visuals and text than other modal elements. Figure 4 shows interaction density, which indicates the number of segments per minute, on modes in each session. Discussions on comics were at high frequency, especially in sessions 4, 8, 9, and 10.

Multimodal comics could expand discussion topics through visualizations of details during peer interaction

Making learning visible in different modes was critical to foster peer interaction (Jahnke, Norqvist, & Olsson, 2013). During interviews, both Camila and Luka commented that they had discussions focused on various details about the comic, from story plot to gestures of avatars. Camila explained, "I think he (Luka) definitely did a good job of making the comics because they match with what I was writing and we had the same details." As an example of interactions surrounding details in the composing process, Figure 5 shows how Camila was confused by the visual of Brad in the pharmacy because it wasn't consistent with her understanding of the narrative. Luka clarified plot elements and Brad's role based on the visual. In this case, comics expanded topics of discussion by making details visible.

RQ3: How did different modes mediate different types of peer interactions?

Different modes supported self-oriented and group-oriented contributions in unique ways

Results showed that there were interactional differences based on different modes. Figure 6 presents the percentage of each interaction type in different modes and reveals that animations, music, and multimodal comics provided roughly equal opportunities for self-oriented (i.e. operating on the speaker's own ideas) and group-oriented (i.e. responding to others' ideas) contributions. In contrast, images and text favored more self-oriented than group-oriented contributions. The comparison indicated that students were willing to provide feedback on partners' ideas or requests while discussing sounds and self-created visuals.

While comparing discussions on static visual modes, namely images and multimodal comics, we found that images involved more self-oriented and less group-oriented contributions. For instance, Luka shared an image by stating that "this alien is disgusting" right after the team decided to include alien zombies in the story. In this case, Luka had already had a specific visual to search for and thus he could focus on the alien, which left limited space for interaction. In addition, the fact that students could not find ways to edit these online images might have also constrained their

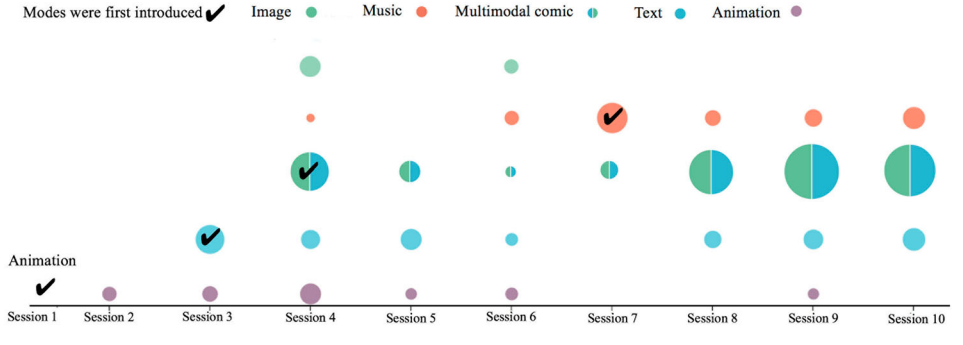


Figure 4. Interaction density (number of interactional segments per minute) for each mode of representation by each session.

Interaction type	Question	Quick responses	Question	Elaborated responses	Question	Elaborated responses
Discourse	*Camila* (while looking at the comic): Wait, what happened to Brad?	*Luka*: He is alive.	*Camila*: Should Brad still fight outside, or should he come into the pharmacy?	*Luka*: Brad saw a man go down the pharmacy and followed him. That's why Brad is in the pharmacy now.	*Camila*: What are they doing?	*Luka*: Dropping the cure on Chad. Lily is running around to help Brad.
Timestamp	30:17	30:20	30:22	30:29	30:44	30:57

Figure 5. A discussion surrounding a comic that contains visualization of details.

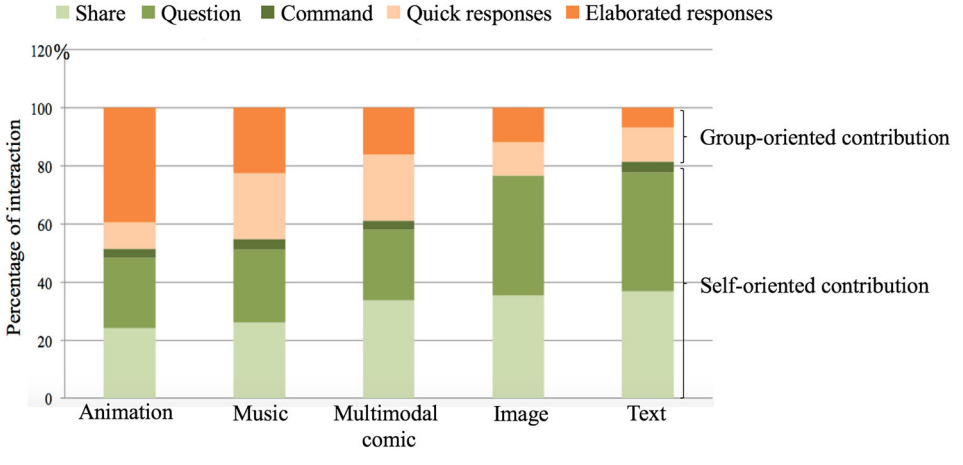
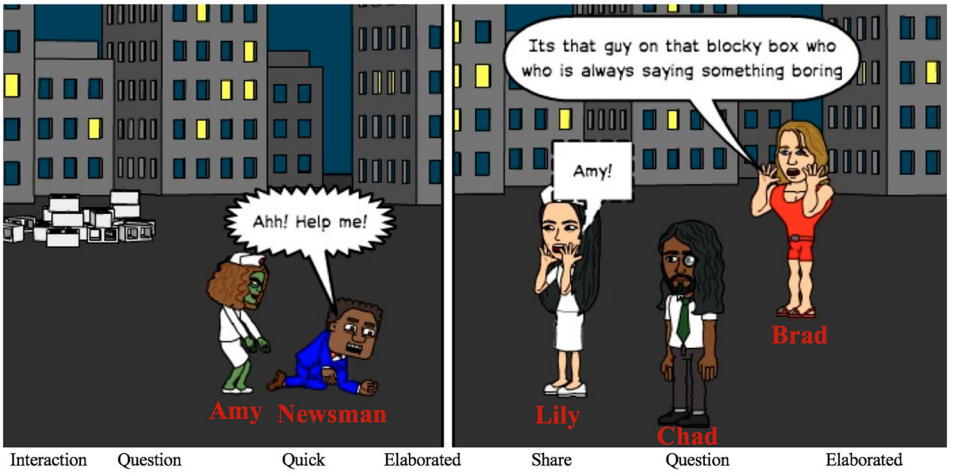


Figure 6. Percentage of each interaction type in modes.

ability to give feedback. In contrast, comics often invited group members to provide feedback. As an example, in Figure 7, Camila asked Luka about her design of a newsman in a specific scene. Luka suggested having Amy chase the newsman and Brad judge the newsman. Instead of focusing on solely the newsman, Luka offered feedback on two additional characters in the comic, Amy and Brad. In interviews, both Camila and Luka emphasized how their discussions mostly centered on providing feedback so that details in text were consistent with details in multimodal comics. Thus, discussions on comics had potential to have more feedback because students had designed additional elements in the comic, and the fact that students could edit these elements also fostered feedback.



Interaction type	Question	Quick responses	Elaborated responses	Share	Question	Elaborated responses
Discourse	*Camila*: Do you like this guy (the newsman)?	*Luka*: Great.	*Luka*: You know what, we should use this guy to chase the newsman. He (the newsman) is so selfish and no one likes him.	*Luka* (Adding Amy into the comic) : Look, this is Amy.	*Camila*: She has a name?	*Luka* (Adding speech bubbles): Yes. Now she is chasing the news guy. Meanwhile, Brad shout out, "he is a boring guy."
Timestamp	51:06	51:08	51:13	52:02	52:05	52:11

Figure 7. A discussion surrounding a comic that provides different angles for feedback.

Discussions on animations included more elaborated feedback. While discussing animations, students needed to explain dynamic information flow. For instance, Camila provided elaborations on Luka's idea of animating people getting infected in session 4 by stating, "that's awesome. So, when getting infected, within a week, people will be fine. But they will turn green after one week." Given the dynamic nature, animations could be considered as suitable for conveying elaborations or explanations about dynamic phenomena while students responded to partners' ideas.

Written narrative provided the least opportunity for group-oriented contributions. Based on classroom observation and student interviews, Camila shared her writing with Luka, "at certain points I would ask them if they had any ideas to add to it. I would tell them to read it over to see if they had any suggestions to add." However, Luka scarcely responded when Camila shared her writing and barely initiated discussions related to text. When asked about his ideas about writing in the interview, Luka responded, "I'm more of a designer. I mean, I could add the picture to the writer's writing." Luka recognized his responsibility in design, which hindered communication with the writer to some extent. However, his role of designer could facilitate discussions on how to integrate design into writing. This finding indicates that students might provide feedback when the discussion was related to modes with which they felt ownership.

Discussion and implications

This study examined one group of adolescents' multimodal composing processes as they collaboratively created a multimodal science fiction. Our analysis revealed how multiple modes mediated – and often fostered – peer interactions. In particular, students interacted with each other in multiple ways and through different modes over time.

The first research question focused on patterns in association with different types of peer interaction when composing with multiple modes. The results confirmed previous findings that students were comfortable leveraging multiple modes as meditational means for ongoing social interaction, such as sharing ideas and seeking support from learning partners (e.g. Hwang & Hu, 2013; Metatla et al., 2012). However, this study adds additional evidence that suggests students tended to use a quick-response strategy while simultaneously composing their individual sections, which may be a critical peer interaction approach for developing multimodal artifacts.

Also, this study illustrates how the focal group's process included three broad composing stages: mode and story exploration stage, mode-story integration stage, and mode-story completion stage. These results are echoed in previous studies that suggest multimodal composing processes are recursive with students revisiting the same mode multiple times (Bruce, 2009; Smith, 2017). However, this study provides a new understanding into three unique stages connected to interactions during the multimodal composing process. Even though students talked about both mode and story in all three stages, they tended to discuss modes or story content separately in stage 1, while discussing more about linking those two in stage 2 and focusing on moving on with tasks in stage 3. Each of these stages appears to represent a growing comfort with multimodal composing practices. The shift from stage one of mode and story exploration to stage 2 of mode and story integration might reflect a change in students' attitude in meaning making with multiple modes. Dominated by quick responses, stage 3 of mode and story completion represented that students were clear about each other's contributions. This finding suggests that teachers can check whether students reach milestones in their composing stages, and also scaffold classroom sessions so students become comfortable and effectively connect modes to story elements earlier in their process.

The second research question explored how peer interactions centered on modes developed over time. Our findings focused on this question are consistent with and extend previous studies of modal preferences (Kress, 2010; Smith, 2017). In this study, multimodal comics, which integrated visuals and text, dominated group discussions. The preference for discussing multimodal comics reflects students' understanding of affordances comics possess in certain collaborative tasks. Our results contributed to the literature on why students preferred comics. Through investigating group discussions, we concluded that the visualizations of details made comics a popular multimodal artifact. Given the fact that students self-created avatars that had similar appearance to themselves, their frequent interactions within comics could also come from students' identity projection through their avatars. To evoke peer interactions, teachers can introduce visual modes that provide flexibility in changing details (e.g. the gesture of characters), and encourage students to design and use avatars that represent themselves in their multimodal projects.

The purpose of the third research question (RQ3) was to investigate how modes impacted different types of interactions. Previous research describes how multimodal composition is collaborative in nature (Burnett, 2016; Metatla et al., 2012; Suthers & Hundhausen, 2002). Reaffirming existing literature, modes of representations that were dynamic (e.g. animations) had potential to support elaborated feedback (Sangin, Dillenbourg, Rebetez, Bétrancourt, & Molinari, 2008). However, few studies have examined how different modes mediate collaboration. We found that some modes (animations, music, and multimodal comics) provided equal opportunities for self-oriented and group-oriented contribution, while some (images and texts) favored more self-oriented contribution. In order to facilitate students in easily moving between expressing their own ideas and responding to others' ideas, teachers might need to make clear connections between modes to foster flexible navigations between self-oriented and group-oriented contribution. For instance, teachers can design an activity in which students create animations to show dialogues in comics. In this activity, students should record voices and add background music for each comic panel. Activities like this connects voice narrations, music, multimodal comics, and animations in meaningful ways.

Students in this study had the freedom to follow individualized modal paths when composing. Through their interactions, it's apparent that students understood the affordances of different modes for different purposes. From this basis, some important areas for future research include

exploring features of modes that would direct students' modal preference, and factors (e.g. group dynamics) that would influence students' choice of modes. In addition to mode preferences, students used the multimodal space in ways that are meaningful to them but unanticipated by teachers. Further research is needed that investigates how to prepare educators for scaffolding productive discussions mediated by a variety of modes and media.

Since this study only examined one small group of students composing in a specific instructional context, much more needs to be understood about how different modalities mediate peer interactions with differing students, contexts, tools, and genres. For example, more information is needed on the degree to which quick-response strategy affect providing other interaction types and quality of multimodal composing artifacts. In addition, it's critical to investigate how changes in group dynamics (e.g. absence of team members) influence peer interactions in multimodal compositions. Future research could also focus on understanding why (e.g. the result of instructions or an organic growth pattern) and when students make transitions between composing stages as well as what roles teachers should play to support and transform each stage. The scope of this study was confined to how students interacted in our project and did not capture their interactions that occurred outside of the project. Further research is needed that traces students' interactions across online and face-to-face contexts.

Finally, these findings raise important issues concerning understanding and scaffolding peer interaction during multimodal composing processes. Collaborative interactions were integral for students to construct engaging and complex science fiction narratives. During the process of meaning making and social interaction, one challenge is to balance the freedom for students to build their own collaborative processes (e.g. choosing preferred modes) with guidance to direct them towards meaningful collaboration. The other challenge is to encourage students to value peers' contributions and provide critical feedback. Despite these challenges, we see the potential of multimodal composing in nurturing students' collaborations through providing open and flexible space for students to co-construct knowledge.

Note

1. This tool is no longer available.

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