FEATURE ARTICLE

Using Apps to Support Disciplinary Literacy and Science Learning

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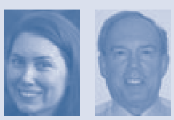
This article showcases apps that help students access information, interpret and share information, and create multimedia products. Classroom examples illustrate how to use these tools strategically to enhance learning.

A large number of apps (specialized programs used on mobile computers) are now available for use in science classrooms. These apps make it possible for students not only to access information but also to make sense of content in new ways. In thinking about apps, it is important to go beyond their technological features to consider the affordances fostered by their use. We define *affordances* as those specific disciplinary literacy practices or tools that mediate the relationships between students and learning goals (Vygotsky, 1962).

One way of identifying app affordances is in terms of the disciplinary literacies associated with science. In contrast to traditional content reading approaches in which literacy is taught as skills or generic practices applied to *all* disciplines, a disciplinary literacies approach recognizes the need to teach those literacies unique to the knowledge, beliefs, language, and discourses specific to disciplines (Draper, Broomhead, Jensen, Nokes, & Siebert, 2010; Moje, 2011, 2012).



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Reading in science requires disciplinary literacies that differ from those needed to read a poem, an historical analysis, or a musical score. It requires the ability to process technical terms within complex clauses such as "the atom-smashing process resulted in the creation of new compounds," which can be difficult for students to grasp and comprehend (Alvermann, Gillis, & Phelps, 2012). It also requires that students learn to read science texts in the ways that scientists do, by formulating guiding questions or hypotheses and gathering data to test those questions or hypotheses.

For example, in one study, expert readers in chemistry focused their attention on the recency of a report, visual presentation of images/data, and the ways the report corroborated related findings or challenged findings in other reports (Shanahan, Shanahan, & Misischia, 2011). These expert readers reread parts they viewed as significant, assessed the plausibility of the scientific evidence cited in the report, and focused on new information consistent with their interests.

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In this article, we feature lessons learned as we partnered with three middle grade teachers to integrate and exploit the affordances of concept-mapping, note-taking/annotation, and screencasting apps as students engaged in inquiry-based science learning. We use the term *science inquiry* to refer to science instruction wherein students are encouraged to pose questions, explore resources, and collect evidence to address questions and validate competing claims.

Although the classroom examples featured in this article illustrate the uses of apps for middle school science instruction, we believe that these app affordances apply to learning in all subjects when modified to recognize the disciplinary literacies unique to those subjects. As literacy educators, we were intrigued with how these teachers devised activities involving app affordances typically associated with literacy instruction to support disciplinary literacies and learning in science.

Common Core Science Literacy Standards

Within the Common Core State Standards (CCSS) in English language arts (ELA) for grades 6–12 is a section entitled "Literacy in History/Social Studies, Science, and Technical Subjects" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The reading standards in this section include important elements such as citing specific textual evidence to support claims and summarizing the broad ideas in a text using textual information rather than opinions.

The CCSS for writing require that students write explanatory texts that introduce and establish a topic and develop that topic using well-chosen, relevant facts, data, details, quotations, examples, or other information. It is important to note that these standards address specific disciplinary literacy skills and are not separate but, rather, reside *within* the ELA standards. This suggests the importance of teachers fostering learning of the disciplinary literacies unique to their disciplines, in this case, science.

Purposes for Using App Affordances for Learning in Classroom Contexts

Three important literacy practices afforded through uses of apps are collaboration, multimodality, and shared productivity (Beach & O'Brien, 2012). One important disciplinary literacy of science involves *collaboration*—peers collaboratively sharing competing claims and evidence. The use of concept-mapping, note-taking/annotation, and screencasting apps allows students to collaboratively share their analyses of observations and data with one another to bolster their claims through evidence.

Another important disciplinary literacy in science involves *multimodality*—the ability to carefully observe and identify specific multimodal, visual features of a phenomenon to explain it. An app such as Leafsnap (tinyurl.com/68hv8d7) can be used to identify different tree species based on photographs of leaves, flowers, fruit, seeds, or bark. Similarly, Solar Walk (tinyurl.com/3y5uakz) can be used for observing planetary objects in space. These apps foster multimodal affordances that promote capturing and identifying phenomena.

A third disciplinary literacy of science involves *shared productivity*—the ability to produce reports or products to share publicly with others. For example, students can use concept-mapping, note-taking/annotation, or screencasting apps to create texts for peers, teachers, and parents to view online.

It is important to recognize that these affordances are not *in* the apps. Uses of these apps are part of a learning context created by the teacher (Hutchison, Beschorner, & Schmidt-Crawford, 2012). Their efficacy depends on how they are used to foster certain disciplinary literacies. Students will best use these affordances in a purposeful manner if and when they are engaged in a collaborative activity that involves, for example, the use of note-taking/annotations to share ideas with their peers for specific purposes. This requires creating a context in which students perceive some benefit from sharing ideas and come to value working collaboratively with their peers as a way of examining multiple points of view.

As we think about ways to use technology to transform student learning, we must also consider how these apps help to mediate students' self-perceptions and sense of agency. Moje, Stockdill, Kim, and Kim (2011) found that self-perception was a factor in their success in school. By displaying competence in their uses of apps, a student may acquire a sense of agency

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as a scientist and use it to contribute knowledge to others.

Affordance: Collaboration

One primary affordance of all apps we will discuss is that of fostering students' collaboration in working together to accomplish the same task. Collaboration is enhanced when students are attending to the same material object or shared goal related to that object. The use of concept-mapping, note taking/annotation, and screencasting apps serves to focus different students' attention on the same material or visual object.

For example, in using a screencasting app such as ShowMe or VoiceThread, students view the same image or video clip to share ideas and react to one another. Another example is the use of a note-taking/annotation app such as Evernote or Diigo. These apps allow students not only to clip texts from websites but also to record their notes related to the clips. Students can cooperate in meaning making by sharing their notes with peers. In addition, other students may spot their sticky note, read the annotation, and respond with their own connections.

Affordance: Multimodal Transfer Between Print and Visual Literacies

Inherent in the Common Core State Standards is the push to help students develop the ability to interpret and communicate information visually through the use of images, photos, graphs, or figures (Shanahan et al., 2011). This disciplinary literacy is vitally important in science as well. Effective use of visual communication requires students' ability to interpret and use visual images to capture a particular scientific phenomenon. As Kress (2003) noted,

> The current landscape of communication can be characterized by the metaphor of the move from *telling the world* to *showing the world*.... New forms of reading, when texts *show the world* rather than *tell the world*, have consequences for the relations between makers and re-makers of meaning (writers and readers, image-makers and viewers). (p. 140)

Rather than simply describing a phenomenon—for example, the influence of climate change on the melting Arctic—students learn to show the world by using both text and images of ice melting in the Arctic to illustrate their ideas. This visual affordance also fosters transfer between visual modes and students' collaborative verbal or written sharing of ideas (Wagner, 2012).

To create multimodal texts for reading on e-readers, teachers and students are now using the iBooks Author app (tinyurl.com/875lxud; produced on a Mac running OS 10.7 Lion), which allows them to create books for sharing on the Apple iBookstore. Some have used the ePub export option and Pages, Apple's word processing program, to create PDFs that students can store and access on iPads (for those using Kindle Reader for iPad, see tinyurl.com/74kvms2). For example, Andrea Santilli and her seventh graders created the 133-page e-book *Creatures, Plants and More: A Kid's Guide to Northwest Florida* (tinyurl.com/dyefat4), which includes many images of creatures and plants; the book is a top seller in the Apple iBookstore.

Teachers and students are also using screencasting apps for fostering visual communication (see Table 1). These apps include the ability to record a digital copy of an image or video and allow users to add their own audio, drawings, or written comments. In our work in classrooms, students have imported images into a screencasting app and then added audio or written comments to express their understanding of science content.

When students add drawings to images, that visual processing then transfers to their use of voice-over commentary about the images as illustrations of their commentary. In turn, by adding commentary about images, they may perceive the need to add drawings to the images that will further illustrate that commentary. In this back-and-forth transfer between oral commentary and drawings, the app affordance mediates recognition of the *potential* for multimodal use of either the commentary or drawing to communicate ideas. Engaging in such activities helps students move from the context of interpreting and critiquing images, videos, or written texts to the rhetorical context of convincing others of the validity of those interpretations or critiques.

TABLE 1 Screencasting Apps

VoiceThread: ed.voicethread.com/mobile
ShowMe: www.showme.com
Explain Everything: www.explaineverything.com
Screenchomp: tinyurl.com/3qbsc5g
Educreations Interactive Whiteboard: tinyurl.com/btdxmsy

Affordance: Sharing of Productions

Another important affordance for many apps is the ability for students to readily share their productions, such as a concept map, annotation, or sticky notes, with audiences to elicit comments or feedback. To convince audiences of the validity of their arguments, students need to know how to move from the context of interpreting and critiquing images, videos, or written texts to the rhetorical context of convincing others of the validity of those interpretations or critiques (Nowacek, 2012). Instruction should emphasize the importance of determining how students' selection and analysis of images engaged their potential audiences.

Given the science disciplinary literacy of supporting one's claims with convincing evidence, providing students with advance notice that they will share their productions with an audience encourages them to be more aware of the need to use language, images, and/or video in rhetorically effective ways to convince the audience of the validity of their claims. Thus, when students are selecting an image for their screencast, they need to consider whether that image and their drawings will provide evidence to help sell their claim to their audience.

We now turn to describing classroom examples of early adolescents using particular concept-mapping, note-taking/annotation, and screencasting apps whose affordances fostered learning of science disciplinary literacies. These examples illustrate how teachers exploited these app affordances to achieve their own particular learning objectives. In each example, it is clear that the app affordances are not simply *in* an app but, rather, are used as *mediating tools* that connect students to the classroom goals driving their activity.

Concept-Mapping App: Popplet Lite

Concept-mapping apps help students visually represent logical or causal relationships between ideas associated with a certain phenomenon. In using concept-mapping apps, students identify a variety of keywords associated with an experience, topic, or issue and visually organize the logical relationships between these words. Students may insert the words into circles or boxes, drawing lines between ideas with spokes to which they insert subtopics. These connecting lines serve to define the logical relationships between ideas, for example, whether a subtopic serves as an illustrative example of a major topic.

Within many concept-mapping apps, students can create an outline list of words with subcategories within those words, and the apps will then generate different types of maps using these outlines (see Table 2). Many concept-mapping apps also include the affordances of color coding ideas as a means of visually representing different categories of information.

Use of concept-mapping apps helps students collaboratively develop and expand topics. By sharing the concept maps, a group of students working on the same project can visually represent their thinking for one another so that they are literally and figuratively on the same page. Students can then pose questions of one another based on their maps, such as questions about connections between ideas or the need for more information to solidify understanding of a topic. Although concept mapping can also be accomplished using paper and pencil, revision capabilities are limited. In digital form, substantial changes can be made effortlessly, making revision more palatable to students.

Students can also use their maps to define an overall focus for their project. Students' maps may begin with a limited number of ideas, but as they develop other sections of their maps they may recognize that their focus has shifted. This shift in attention signals the need for revision to alter their overall focus.

Students in Laura Kretschmar's sixth-grade science class used the free Popplet Lite (tinyurl.com/3o6a3wy) concept-mapping app to extend their learning about rare earth metals. They were asked to create a concept map to address the question, "What is gold?" Popplet Lite allowed students to create a connected set of boxes to map their conceptual understanding in their own words. Students used the touch screen to zoom in or out on their maps, move the information around as they added new ideas, and

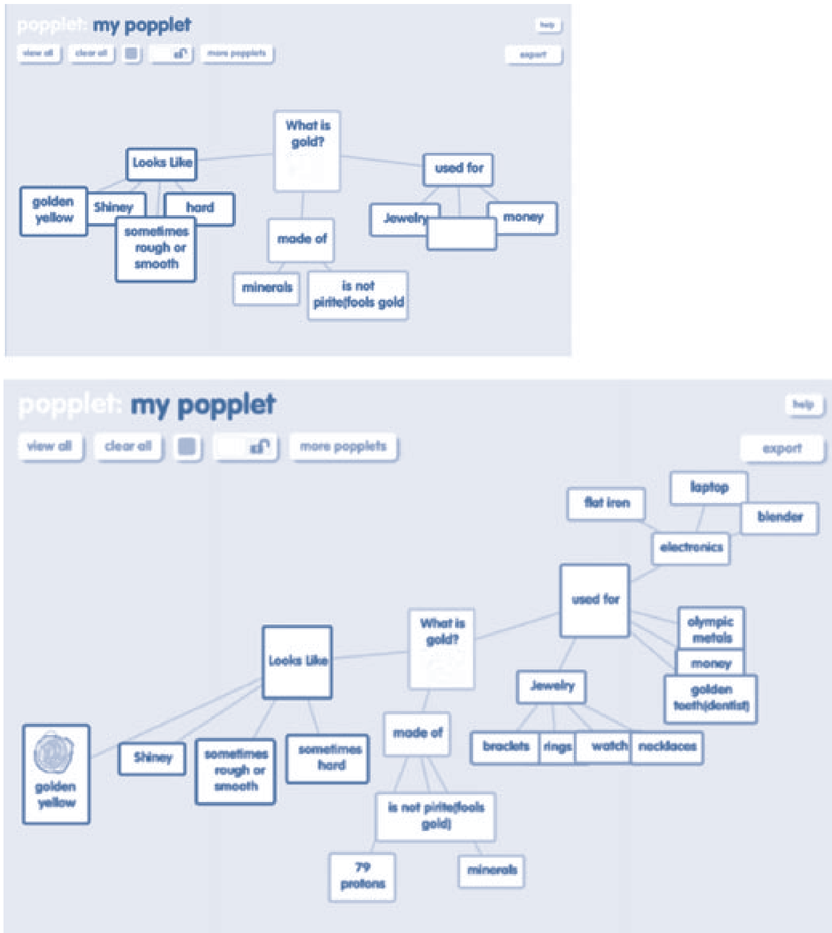
TABLE 2 Concept-Mapping Apps

MindMeister for iPad: tinyurl.com/7t47atk
Inspiration Maps Lite: tinyurl.com/6p4folr
Mindjet for iPad: tinyurl.com/863dgjy
iBrainstorm: www.universalmind.com/work/ibrainstorm
Sundry Notes: tinyurl.com/6tkesap
Idea Sketch: tinyurl.com/7nerblt
Total Recall: tinyurl.com/855oj7w
iMindMap: tinyurl.com/87baa2k
MindNode: tinyurl.com/7comdg6
Popplet Lite: tinyurl.com/7h64yej

include images and color coding to their maps. When their final products were complete, students could then export their concept maps as PDF or JPEG files.

After students drafted an initial map, they shared their creations in small groups with the purpose of gathering new ideas and revising. When revisions were made, students took a screenshot of their expanded map to create a record of their thinking. To do this, they simultaneously clicked on the power button and the iPad home key.

FIGURE 1 Andrea's Initial and Revised Concept Map Illustrating "What Is Gold?"



Laura was skilled in helping her students access resources to expand their knowledge to elaborate and build out their maps. The act of concept mapping allowed them to organize information and demonstrate new levels of understanding. Initially, Andrea (pseudonym) created a map with a limited number of topics (see Figure 1). Then, based on her interactions with peers and examination of resources, Andrea's revised map included more specific, interrelated development of topics, including specific types of jewelry or other products. As students revised their maps, their knowledge grew. It was clear that as they gathered information, they became more successful at grouping like ideas and reorganizing those ideas.

One key affordance in the use of concept-mapping apps is the visual grouping of different attributes, features, or examples of a concept, in this case, identifying different uses of gold for making certain products. Creating a concept map beginning with what students already know encourages them to perceive the potential for linking additional ideas they will learn as they read, explore, and exchange ideas with peers—an example of transfer from the visual to the verbal. Moreover, the ability to visually link concepts through logical connections or groupings fosters students' use of causal/hierarchical thinking. Further, the affordance that students could easily view other students' maps on their iPads led to collaborative brainstorming and easy-to-make revisions during brainstorming and initial map creation.

This use of concept maps demonstrates that the app's affordances foster the ability to elaborate and revise while constructing knowledge over time and through collaboration with peers. In reflecting on their experience creating maps, students noted that revising their maps cooperatively with peers "helped me because when we were sharing, I got new ideas," "revising made my map better," and "sharing made me get more ideas and check if I got words wrong."

Use of Note-Taking/Annotation Apps to Foster Collaborative Knowledge Construction

Students' ability to engage in close reading, focusing attention on and reviewing specific information, is a critical disciplinary literacy involved in understanding science texts (Shanahan, et al., 2011). Students can use note-taking/annotation apps such as Evernote, Diigo, iAnnotate, or DocAS (see Table 3) to target specific information and summarize key claims or findings. When using digital annotations to raise or pose their own questions, students have the ability to build on one another's questions with their own annotations and are exposed to alternative responses that may differ from their own, resulting in their appropriation of new ways to interpret texts (Coiro, Castek, & Guzniczak, 2011). This sort of perspective taking involves recognizing alternative claims, and the evidence that supports them, while also thinking through counterclaims that refute alternative explanations.

Students in Melanie Swandby's seventh-grade science classes used the Diigo and DocAS annotation apps to examine the pros and cons of wind energy. Students were provided with two articles: a pro article arguing that wind power offers several positive benefits and a con article arguing that wind power is not cost effective. The students read the articles on their iPads and used the apps to annotate the texts.

To complete their annotations, students used the Diigo social bookmarking/annotation app and Web highlighter to mark up the articles. The app allows students to add annotations as sticky notes right within the text they're reading. In this lesson, students posed questions and made reflections/connections to ideas within the text. Diigo also has a collaboration feature that allows students to share their sticky note annotations within their classroom group.

As illustrated in Figure 2, when adding sticky notes directly on the Web text of the article, students could target their annotation to a specific line in the text. The fact that students posed questions such as "How much does the wind turbine cost?" or "How many birds does the wind turbine kill in a year?" demonstrates that they were engaged in the inquiry process of formulating questions that led to the collection of evidence to address these questions. Students also used their annotations for connecting their prior knowledge to define the benefits of turbines. They read other students' sticky notes and collaboratively built on their peers' annotations.

TABLE 3 Note-Taking/Annotations Apps
Evernote Web Clipper: tinyurl.com/m4z9gz
Diigo: www.diigo.com/education
iAnnotate PDF: tinyurl.com/2whcqsj
DocAS: tinyurl.com/77pcr2u
GoodReader: tinyurl.com/y2v9h3g
Readdle: tinyurl.com/73suvvo
Notetaker HD: tinyurl.com/4kxe329
UPAD: tinyurl.com/63n9w6y

For example, students noted that "wind energy is free and keeps the air clean instead of polluting the air," "people could install wind turbines to generate energy," "coal isn't a good source of energy," and "wind power has many advantages that we could use." The sticky notes drew students' attention to their peers' interpretations of specific claims. This connected train of responses demonstrates the potential for collaborative co-construction of related prior knowledge to support content acquisition and the formulation of arguments.

By reading one another's annotations, students in Melanie's class were exposed to questions and connections that differed from their own, resulting in their acquiring new ways of interpreting texts (Coiro et al., 2011). Students discussed their annotations in pairs to exchange ideas and clarify their understanding. For example, they used sticky note annotations to respond to one another's questions and claims, as illustrated in Figure 2. One student posed the question: "Why are they complaining about the turbines? It doesn't even look bad." Another student responded by posting: "That's what you think, but have you actually been near a wind turbine or lived around one? (close to one?)." This collaborative, argumentative exchange was fostered through the use of the sticky notes (Beach & O'Brien, 2012, p. 139).

On a different day, students were provided articles in PDF form and were introduced to the DocAS app. One advantage of this app is the manner in which students can highlight, handwrite, or type directly onto PDF files and have the full annotations viewable (as opposed to using sticky notes in Diigo, which are collapsed until clicked on).

As Marco (pseudonym) was reading, he added the following annotation, "Wind turbines should be repaired because it is a waste of the beautiful landscape." Another of Marco's annotations involved stating a claim and then supporting it with evidence drawn from the texts. It read: "The wind turbines should've never been built there because it makes the beautiful landscape unattractive and it only powers 1% of the CA population, which is about 350,000 people."

After annotating the texts, students used the Notebook features in Diigo and DocAS to synthesize

FIGURE 2 Shared Diigo Annotation Sticky Notes

thinking and formulate arguments drawing evidence from the articles they read. Students were directed to skim through the articles to identify key points supporting a pro or con position. Marco drew from his annotations to formulate an argument that took into consideration both the pro and con perspectives. In his DocAS notebook, another feature of the app, he wrote:

> Everything has something bad about it, wind energy is renewable but sometimes it is a waste of energy. In my opinion, it's a bad thing because if one of the wind turbines is broken, there's no law for that company to fix them. Yes, some people might say its renewable and causes no pollution. Wind energy has some things that are good about it but overall it's a waste of space and money to build.

What is evident in this example is Marco's awareness of the need to provide reasons for his thinking and include evidence to sell his claim. He uses phrases such as "in my opinion" and then supports his claims with information gleaned from the articles he read and annotations he made. By going through the process of annotation, students such as Marco made effective use of their annotations as prewriting to generate an argument. In many cases, using their annotations to pose challenging questions about the articles they read led them to adopt a critical stance regarding the benefits of wind power, a stance they then adopted in their writing.

Using Screencasting Apps: Mediating Communication Through Shared Images

Key to effective collaboration is productive social interaction. Walsh (2011) defined this interactive communication, or “confluence,” as “the act of making spoken language fluent together with another speaker [through] ways in which speakers attend to each other’s contributions and focus on collective meaning making” (p. 160) by listening to one another, engaging in effective turn taking, and elaborating topics. This confluence can be mediated through sharing images as externalized “inscriptions” (Pea, 1994) of individual members’ understanding, so that collaborating students are then literally and visually on the same page.

As previously noted, screencasting app affordances mediate this shared visual thinking. In one screencasting app, ShowMe, students can import a series of images onto a virtual whiteboard and then draw on the images to convey ideas as they record audio to explain their thinking. They can also draw over an image to emphasize certain features or create their own drawings (see Lisa Garcia’s ShowMe presentation on tropical rain forests at tinyurl.com/c4yfeob). They can save their project to ShowMe and share the URL with a wider audience.

Students in Linda Wilhelm’s seventh-grade science classes used the ShowMe app to deepen their study of Mendelian genetics. Students worked in pairs to create a ShowMe video based on reading key ideas from four different readings.

To illustrate their understanding of the science content from the readings, students storyboarded directly into ShowMe. These temporary sketches served as a form of prewriting and drafting of ideas that students collaboratively reviewed and revised. Because they could easily erase and redo their work, partners evaluated their drawings and revised to make them more consistent with their ideas. In this revision process, students tested out alternative ways to visually convey their ideas to determine which visual representation best captured their intended meanings. Students went back to the articles as well as their other sources of information (such as their textbooks) to clarify their thinking about their presentations.

At the same time, because their images were perceived as highly temporary and easy to erase/revise, the affordance of the temporal fostered students’ own verbal revisions, an example of transfer between the visual and the verbal. Once students recognized that their drawings didn’t quite capture their ideas, and they erased and generated a new version, their revision helped them clarify their voice-over description. For example, in creating a drawing of a cell mutation, one student noted that the drawing wasn’t clearly conveying the process, so the student noted “let’s do it this way” and created a revised drawing, which then served to help both students clarify what they wanted to say about cell mutations.

Because the students were working collaboratively, and both were required to talk about their work, the multimodal act of drawing helped them coordinate and choreograph their shared talk. Because the students could examine the same images and readily revise those images, these shared artifacts served to scaffold and focus collaboration.

Linda’s students exploited the ShowMe app affordances to learn not only how to convey their ideas about genetics using images and narration, but also how to develop, revise, and clarify those unfolding ideas. For example, two students thought carefully about their presentation on the dominance of certain traits influencing a baby’s eye color (Beach & O’Brien, 2012, p. 288). They posed the question, “If a brown eyed and a blue eyed parent had a baby, what color eyes would the baby have?” They then drew two parents, “Bob” with blue eyes and “Suzy” with brown eyes, along with the couple’s baby (to view the presentation, go to www.showme.com/sh/?h=ibbycYS).

They added a question mark next to the baby to illustrate that they were posing a question related to the dominance of a certain trait. They then created a drawing showing that “this is the child and the child’s eyes are brown because brown was dominant.” These students’ shared drawings served to foster their verbal voice-over commentary, commentary that in turn required the use of illustrative drawings.

Use of VoiceThread for Study of Dinosaur Extinction

Another useful screencasting app is VoiceThread (voicethread.com). Our examples focus on VoiceThread for iPad, but a version of the app also exists for iPhone or iPod touch (ed.voicethread.com/mobile).

Students can use VoiceThread to engage in collaborative audio discussions or text annotations within a slideshow of images posted to the Web (visit tinyurl.com/3m3rf2r for examples of using VoiceThread across different disciplines). Students can import Creative Commons copyrighted images or video into VoiceThread directly from Flickr. They can then click on an audio button to record annotations or type in their annotations or draw on images as they are commenting.

One advantage of VoiceThread is that peers, parents, and teachers can comment on the projects. Hence, VoiceThread serves to foster collaborative discussion by focusing comments from different viewpoints on a specific production, resulting in multiple, often quite different, perspectives on the same visual artifact. Exposing students to a range of alternative interpretations can lead them to rethink their own interpretations—another positive influence of collaboration. And, because students are sharing their VoiceThreads with multiple online audiences—an example of the affordance of shared productivity—they are motivated to produce high-quality work.

To illustrate the use of VoiceThread to foster discussions, we again draw examples of students' work in Laura Kretschmar's science class. Laura's students created VoiceThread productions on their iPads to address the question, "What caused the extinction of the dinosaurs 50 million years ago?" Students read three articles from which they framed their claims that the primary cause was either a supernova explosion, volcanic eruption, or asteroid hitting the earth.

Working in pairs, the students created VoiceThreads by selecting images of supernovas, volcanic eruptions, or asteroids to visually support their arguments, representing the use of visual means to communicate ideas. They then added voice-overs explaining their positions, incorporating evidence into their arguments to support those positions.

After creating a first draft to communicate their ideas, students viewed one another's VoiceThreads and offered critiques through the text and audio comments feature. By viewing others' work, students were exposed to competing arguments as well as different interpretations of the evidence collected from the articles they read. In some cases, they referenced one another's arguments to formulate their own counterarguments along with evidence supporting those counterarguments, a practice central to inquiry-based science.

For example, two students (voicethread.com/share/2454743) argued that volcanoes were the primary cause of the extinction and used an image of a volcano to illustrate their position:

Take Action

STEPS FOR IMMEDIATE IMPLEMENTATION

Teachers can work with students on the following activities:

- ✓ Use concept-mapping apps to brainstorm ideas and topics for projects or written work. Have students work in pairs to visually identify and connect different topics. Then ask students to pose questions about their partner's maps. Through these cooperative exchanges, students are using visual thinking to develop their ideas (see also Hutchison et al., 2012). The visual representation of their thinking transfers to their written text production.
- ✓ Use annotation apps to share online discussion responses to specific, targeted sections of texts, for example, critiquing specific claims in a science report. Students can also respond to other students' annotations by concurring with, extending, or challenging their thinking. They can then use these annotations to reflect on the validity of competing claims. The visual affordance of seeing yellow sticky notes on a text triggers the potential for further thinking, an example of transferring the visual to the verbal.
- ✓ Use screencasting apps to create analyses of images or video of scientific phenomena, for example, chemical reactions or lake pollution. Students can draw on or annotate images to highlight features of those phenomena. They can also use annotation apps to respond critically to other students' annotations.
- ✓ Develop evaluation criteria or rubrics based on students' uses of specific app affordances. One criterion for examination would be students' uses to use screencasting app-related visual/drawing production with verbal commentary.

> Volcanic eruptions caused dinosaur extinction because dust and ash went to the atmosphere which made the temperatures go down and the dinosaurs couldn't survive, further evidence that a volcanic eruption happened sixty-five million years ago. What caused extinction was a layer of iridium. The iridium came from the dust and air. (Beach & O'Brien, 2012, p. 245)

Two other students (voicethread.com/share/2544219) argued that the cause was a supernova, and they used an exploding supernova to illustrate their position (Beach & O'Brien, 2012, p. 245). Two other students (voicethread.com/share/2545658) who posited that the cause was an asteroid included the image of a large crater. They also refuted claims for the supernova and volcanoes:

> It could not have been the supernova because if a supernova would have been that close to the earth other species on the earth would have died. It also could not have been the volcanoes because why did all of the volcanoes erupt at once? (Beach & O'Brien, 2012, p. 245)

Students' VoiceThread projects (sites.google.com/site/kretschmarexpo2011) were shared with parents and the community during the Fall Expo.

As with ShowMe, students' use of VoiceThread represents the transfer between the visual and the verbal. Students used images to foster and elaborate on their verbal descriptions and discussions. Because they were working collaboratively in pairs, students brought their own particular perspectives, ideas, and knowledge to their work, resulting in each pair playing off of each student's perspectives, ideas, and knowledge.

As is the case in any scientific community engaged in empirical research supporting and refuting differing claims or hypotheses, the students were learning how to participate in and adopt the disciplinary literacy of collaboratively scientific analysis in which scientists posit and refute others' alternative hypotheses. And, because students knew that their peers could access and provide written or audio comments as feedback on their VoiceThreads, their awareness of the audience guided their verbal narrations.

Summary

We have argued that apps can be used in innovative ways to support science and literacy learning. With the skilled guidance of teachers, students can exploit app affordances for learning and use disciplinary literacies unique to science.

For example, students can build conceptual understanding and communicate ideas through the use of concept-mapping, note-taking/annotation, and screencasting apps. These apps allow students to access information and create their own digital products that include rich visual representations. The use of note-taking/annotation apps further supports close reading of science texts.

One key affordance across apps involves an awareness of the potential for transfer of visual and verbal analysis. This is evidenced in the use of drawing in the ShowMe and VoiceThread apps, which foster the use of visual representations and narration to convey ideas. The act of inviting viewer commentary into the projects encouraged students to revise the construction of their ideas, their drawings, and verbal explanations. Take Action offers additional ideas for instructional uses of these apps.

Our classroom examples serve to illustrate that these app affordances were not simply *in* the apps but, rather, that they were fostered by how teachers exploited these affordances to achieve their own specific learning objectives. This suggests that, as with any learning tool, teachers who are beginning to incorporate apps into their instruction need to carefully consider how to use these tools in ways that best serve to enhance their students' learning.

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More to Explore

CONNECTED CONTENT-BASED RESOURCES

Websites for Science Apps

- For general app recommendation sites: tinyurl.com/7hgrw4p
- For specific apps related to literacy practices: tinyurl.com/6oxcn7z
- The Frog Blog 20 Apps for Science Teachers: tinyurl.com/6oznfqm
- Apps in Education: tinyurl.com/7lgvddr
- Appolicious: tinyurl.com/88rrehy
- Getting Smart—Top 10 iPad Apps for Science Learning: tinyurl.com/87yepfw
- Arizona State University Science Lessons—Bird Rap: tinyurl.com/7dm6ls5
- 30 Cool Educational iPad Apps for Science Lovers: tinyurl.com/87qjs59