PERSONAL INQUIRY AND ONLINE RESEARCH

Connecting Learners in Ways That Matter

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This article introduces a framework that envisions Personal Digital Inquiry in K–8 classrooms along a two-dimensional continuum that varies in levels of support and purposes of technology use.

Olivia and Jorge are fifth graders working together to gather information for their Digital Wonder projects. Amber White, their classroom teacher, uses curricular strands as a springboard for inquiry, but she also gives students leeway in crafting the focus of their collaborative explorations. Inspired by their class exploration of Wonderopolis (wonderopolis.org), Olivia and Jorge engage more deeply in their self-selected investigation into how long fingernails can grow. As they discuss how their topic connects to the human body and math (i.e., ratios), Jorge suggests, "The nail is in proportion to the whole finger, no matter the age of the person or the size of their hand."

Ms. White has given parameters for the Digital Wonder projects, modeled her expectations, and provided several prompts to guide students' investigations. To support reflection and enhance students' end products, she also introduces a handful of digital tools, including a student-friendly website maker called Weebly (www.weebly.com) and a voice- and screen-capture program, Screencast-O-Matic (www.screencast-o-matic.com).

Students follow Ms. White's prompting to gather relevant information about their guiding questions. "Let's check this out!" Olivia tells Jorge. "It shows the different parts of the nail and the names of these parts." Anticipating their audience, Jorge remarks, "Yeah, we'll definitely need to include that so they'll know which part of the nail actually grows." Meanwhile, other students are exploring their math- and science-related wonderings about topics such as how to beat a polygraph (see screencast.com/t/WJRslDrTMmd) and full moons (see screencast.com/t/mS7maOn5LEqr).

Throughout the project, Ms. White provides supported opportunities for knowledge building as students read online. She scaffolds how they'll structure their products and helps them adhere to

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progress-setting timelines along the way. Mostly, she encourages their interests and provides time for projects to coalesce as students dig deeper into personally relevant inquiry topics. Toward the end of the unit, Olivia and Jorge publish their Digital Wonder online (see Figure 1 and oliviap1921things.weebly.com/wonderopolis.html) and orally reflect on what they've learned (see screencast.com/t/qUsm1sOG).

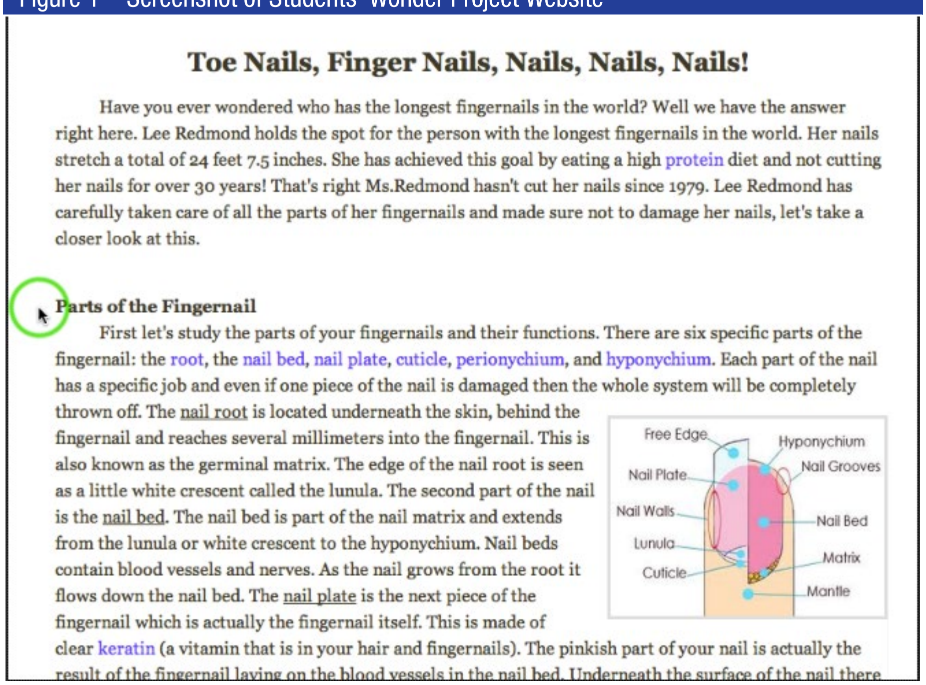
When reflecting on the success of her unit, Ms. White realizes two things: First, inquiry often requires structure and guidance as students learn to ask questions, choose resources, and create products that demonstrate their learning; second, she realizes the need to plan strategically for how students use technology during inquiry. She also feels justified in the time she spent scaffolding inquiry. Her students have learned important content and digital literacies consistent with year-end expectations and Common Core State Standards. More importantly, they have pursued topics meaningful to them and have become more emotionally engaged with their own learning—two goals Ms. White pursued to build opportunities for personal choice into her curriculum.

Connecting Learners in Ways That Matter

As the preceding vignette shows, it is possible, although challenging, to move beyond what Collins and Halverson (2009) called an industrial model of universal schooling toward efforts focused more on lifelong learning and individual choice. Optimistically, the National Research Council (Pellegrino & Hilton, 2012) suggested that if we engage learners with rigorous academic content while expecting them to understand why, when, and how to apply knowledge in order to answer questions and solve problems, these efforts "could lessen the achievement gap…and…lead to positive adult outcomes for more young people, independent of any increases in their years of schooling" (p. 190). In fact, a recent study found that high school students who engaged in these "deeper learning" opportunities demonstrated higher levels of interpersonal and intrapersonal skills and were more likely to graduate on time (American Institutes for Research, 2014). These successes can lead to better outcomes in every aspect of life, including academics, careers, civic life, and health (Hull, 2009).

Although all of this sounds very promising, our conversations with K–8 teachers suggest that a move toward interest-driven digital learning opportunities in an age of accountability can be overwhelming. In this article, we introduce a framework for envisioning Personal Digital Inquiry (PDI) in K–8 classrooms. Although some elements of our framework may be new, we strive to connect these ideas to familiar literacy practices supported by theory and research. To conceptualize what teaching and learning might look like in these classrooms, we situate these practices along a two-dimensional continuum of digital inquiry that varies in terms of levels of support and purposes of technology use. We then offer several examples of what teaching and learning within a PDI framework can look like—visions that move from teacher-directed to student-directed inquiry, always informed by purposeful choices about the role that technology plays along the way.

Figure 1 Screenshot of Students' Wonder Project Website[a]

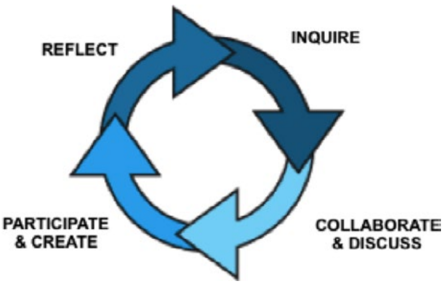


[a]oliviap1921things.weebly.com/wonderopolis.html.

A Framework for Personal Digital Inquiry

The essence of our framework for PDI, as shown in Figure 2, involves a set of practices in which students actively (a) inquire, (b) collaborate and discuss, (c) participate and create, and (d) reflect. These practices integrate classic and contemporary principles of

Figure 2 Core Practices of Personal Digital Inquiry



inquiry-based learning (Bruce & Bishop, 2008; Dewey, 1938/1997) with elements of cognitive apprenticeship (Collins, Brown, & Holum, 1991) and ideas associated with connected learning (see more at www.dmlhub.net) and design thinking (see www.designthinking-foreducators.com). Literacy instruction, within this framework, seeks to actively involve students in deep, authentic, and personally relevant learning experiences that foster academic achievement, reflection, and civic engagement.

Next, we briefly describe what each of these practices involves and how the practices can be implemented to connect learners to their world in ways that matter.

Inquire

Inquiry is at the core of our PDI framework. Bruce and Bishop (2008) defined inquiry as "learning that starts with lived experience…where people actively shape their own learning as they work on real problems within their own communities" (p. 704). We, too, believe that learners grow and change with opportunities to identify problems in their community, generate personal wonderings and engage in collaborative dialogue around these problems, and apply their new knowledge by acting out solutions in ways that transform thinking. Accordingly, Dewey (1938/1997) argued, an emphasis on inquiry provides a logical cycle of learning experiences through which we "remake the world along with ourselves" (Bruce & Bishop, 2008, p. 705). Thus, the goal of inquiry-based learning is to develop engaged citizens with an integrated focus on fostering individual growth, democratic participation, and social change.

Moreover, because of the Internet, today's youths are part of an interconnected global community of learners with an increasing awareness of the world around them. Even young children have the power to engage in personal inquiry experiences around small or large community problems (Hobbs & Moore, 2013). Offering learners space to generate their own wonderings about these problems helps them connect their own interests to real-life issues in ways that can lead to real change (Alberta Learning, 2004). In turn, opportunities for purposeful, self-directed inquiry become personally fulfilling learning experiences (Pink, 2009). Designing purposeful instruction that incorporates students' own wonderings is the foundation upon which our PDI framework is built.

However, students' ability to merge the Internet's networking and knowledge-building resources with the problems they seek to solve is only as good as their skills in jointly generating questions, constructing meaning, generating creative solutions, and reflecting on how to improve these solutions for different contexts. The other components of our framework call attention to these interconnected practices as crucial elements of digital inquiry.

Collaborate and Discuss

For today's learners, doing has become more important than knowing. Members of Generation Y, or individuals born after 1981, prefer and expect learning opportunities that involve collaboration and discussion leading to action (Schofield & Honoré, 2010). In some ways, these experiences are reflected in previously recommended instructional practices that promote literacy and knowledge building through collaborative reasoning (Wu, Anderson, Nguyen-Jahiel, & Miller, 2013), reciprocal teaching (Palincsar & Brown, 1984), and concept-oriented reading instruction (Guthrie, Wigfield, & Perencevich, 2004). In each case, learners work in small groups, and sometimes with designated social roles, to collaboratively construct meaning and support each other's thinking.

However, self-directed online inquiry processes can complicate these social meaning-making experiences. Previously, students who engaged in reciprocal teaching, for example, may have read and discussed carefully selected offline texts informed by a teacher-directed purpose. As learners of all ages turn to the Internet for information to satisfy their personal wonderings, they must learn how to work with peers to (a) search for and

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"Reflection challenges students to deeply consider the social and ethical impacts of their creations and ideas (Hobbs, 2010)."

consolidate ideas across a much larger set of digital texts from increasingly diverse perspectives and (b) select from an endlessly growing set of digital tools to help them access, compare, and organize solutions around potentially controversial ideas. These additional complexities call for literacy experiences that facilitate face-to-face and online conversation-building, argumentation, negotiation, and presentation skills. Our PDI framework seeks to help teachers envision ways of designing personalized digital inquiry experiences to foster collaborative discussions and reflections that, in turn, lead to knowledge building, knowledge expression, and personal action.

Participate and Create

Inquiry ideally leads to student action, through both creation and participation. Participation is an essential step in the inquiry process. In fact, Casey (2013) argued that it is the ultimate goal of learning. Through participation, individuals assert their autonomy and ownership of learning; in turn, their inquiry becomes more personal and engaging (Pink, 2009; Zhao, 2012). Ultimately, creation and participation are essential for knowledge construction and identity development as inquiry shifts from learning about to learning-to-be (Brown, 2005; Dewey, 1938/1997).

Creation is one common form of participation (Reilly, Jenkins, Felt, & Vartabedian, 2012). In PDI, student creations can be either high tech, such as a multimedia website, or low tech, such as a mind map on chart paper. Although high-tech creations may be new to teachers, youth participation in digital media outside of school is common, given the readily available tools and sites for participatory creation (Ito et al., 2013). Creation, which is often an original student product, can also consist of remixing and repurposing existing media for new purposes (Belshaw, 2014). As students participate, they gain experience exploring, creating, and remixing digital media. In turn, they expand their knowledge of digital creation and explore possible starting points for future projects.

Participation can also take the form of civic action. When students investigate personally meaningful problems within their community, they often want to make positive changes or build awareness. Student action may come in the form of digital media creation, such as public service announcements (Hobbs, 2011). In other instances, PDI may lead to more traditional forms of civic action, such as writing editorials or speaking before elected officials.

Importantly, participation is driven by the learner's ability to circulate his or her creation in order to connect more directly with a real audience. Participation and digital creation provide opportunities to link different spheres of students' lives (school, home, and community) in meaningful and relevant ways. Furthermore, these connections help build social networks and bonds between academic content and student interests (Ito et al., 2013). Real audiences provide critical feedback for the next stage of PDI: reflection.

Reflect

Reflection, although the final element in the cycle, can also be viewed as the beginning of inquiry. Although inquiry is associated with the search for a comprehensive answer, ideally, inquiry should also lead to a student's next burning question (Thomas & Brown, 2011). However, reflection on learning in school is often either nonexistent (Costa & Kallick, 2008) or perfunctory. Providing time and space for reflection within PDI is critical for students (Schön, 1983) as they consider content learned, metacognitively examine the processes used, and mull over choices they made to improve the process for future action. Additionally, reflection challenges students to deeply consider the social and ethical impacts of their creations and ideas (Hobbs, 2010). Reflecting on action also enables students to reframe problems, identify gaps in their knowledge, and decide what additional inquiries may be necessary (Casey & Bruce, 2011).

"Creation and participation are essential for knowledge construction and identity development as inquiry shifts from learning about to learning-to-be (Brown, 2005; Dewey, 1938/1997)."

Reflection also involves rethinking the roles that creation and participation play in learning. Typically, creation and participation are considered the culmination of learning. Instead, Papert (1987) argued, creation might best be viewed as the production of "an object to think with" (p. 25) that makes a student's meaning making visible. Drawing upon design thinking principles (IDEO, 2013), reflection becomes a driving force behind creation as it prompts feedback and discussions necessary to understand the social impact of one's ideas. Reflection should be ongoing throughout the design thinking process to enhance later investigations, discussions, and products.

Figure 3 Levels of Inquiry That Gradually Release Responsibility

Modeled inquiry	Learners observe models of how the leader makes decisions. This might be the sole purpose of an inquiry experience, or the leader might model specific practices while explaining to students what is expected of them in less supported phases of inquiry.
Structured inquiry	Learners make choices that depend upon guidelines and structure given by the leader. Structure often varies according to the learners' ages, abilities, and interests.
Guided inquiry	Learners make choices in the inquiry that lead to deeper understanding, guided by some parameters given by the leader.
Open inquiry	Learners make all of the decisions, and the focus is based primarily on their interests, wonderings, and goals. There is little to no guidance from the leader.

Note. The ideas for this figure stem from *International Baccalaureate Primary Years Programme Category 3S: Inquiry in the PYP: Supplementary Workbook* (p. 13), by C. Babin & L. Rhoads, n.d., retrieved from pypinquiry.wikispaces.com/file/view/Supplementary+Workbook+-+3S,+Inquiry+in+the+PYP+-+Babin+%26+Rhoads.pdf

Understanding Teaching and Technology Use Within a PDI Framework

After understanding key practices associated with digital inquiry, the next important question to address is what role technology should play in a PDI framework. Rather than making decisions informed by what Johnson (2014) called "the false dichotomy of either print *or* digital media, pedagogy *or* technology" (p. ix), we believe it makes more sense to first consider desired learning outcomes (e.g., learning content; community participation) and then make informed choices about which instructional practices and technologies, if any, would be most meaningful for those purposes. Thus, in this section, we introduce a concrete way to conceptualize these decisions along two dimensions that highlight the integral relationship between pedagogy and technology use.

Understanding Pedagogy as Part of Digital Inquiry

Our PDI framework situates classroom inquiry experiences within one of four gradually less restrictive levels of support that teachers can use to encourage inquiry-based learning while also accomplishing curricular or participatory learning outcomes. As described in Figure 3, these varied levels of support seek to transition learners through phases of modeled inquiry, structured inquiry, guided inquiry and, ultimately, open inquiry. In many ways, this gradual release of responsibility mirrors phases of balanced literacy instruction that guide learners through modeled, shared, guided, and independent reading experiences matched to their individual needs.

Inherent in our PDI framework is the understanding that learners grow and move through these levels at different speeds. Similar to literacy instruction, instruction around inquiry is differentiated to meet the changing needs of all students.

Nevertheless, building a culture of inquiry that emphasizes problem solving and "learning how to learn" is crucial at any level of inquiry. Notably, students engaged in inquiry-based learning become more creative, more positive, and more independent in ways that prepare them for problem solving and lifelong learning (Kühne, 1995). Thus, these four levels of inquiry provide tangible approaches that one might use to structure classroom inquiry experiences for a variety of learners.

Understanding Technology Use as Part of Digital Inquiry

In addition to structuring the inquiry process itself, it is also important to consider how to balance meaningful ways of using technology. When making these decisions, Harris and Hofer (2009) recommended an *activity types* approach, whereby digital applications are not selected until learning goals and activity types are finalized. Activity types capture what teachers and students do when engaged in a particular learning-related activity.

To guide decision making, Harris and Hofer (2009) sorted a wide range of curricular activities into three categories of activity types that provide students opportunities for *knowledge building* (i.e., students are expected to build content and process knowledge), *convergent knowledge expression* (i.e., students are expected to develop and express a similar understanding of content), and *divergent knowledge expression* (i.e., students are encouraged to express their own understanding of a given topic). For each type of activity, a range of possible technologies can deepen and extend learning. Harris and Hofer stressed the value of combining individual activities and corresponding uses of technology into more complex projects and learning units. It is here, when we begin thinking about how activity types matched with purposeful technology can be woven into inquiry practices, that we are inspired by the potential power of digital inquiry experiences.

Still, we envision at least two additional activity types worth considering as part of digital inquiry. First, especially in the early stages of inquiry, we believe that there is value in using technology to help students *acquire information* as a first step toward active knowledge building. On-demand informational videos, virtual presentations, and informational websites with text-to-speech features are especially useful ways of giving younger students access to information they might not yet be able to read independently. Pairing this type of technology use with practices around modeled and structured inquiry can enhance content knowledge, enhance literacy learning, and foster social learning and collaboration (Pelekis & Phillips, 2014).

Another category of activity types for which technology might be used involves learner *reflection*, whereby students privately and publicly discuss what they bring to the content and what ideas they actively construct as they interact with content and technology. For example, during inquiry, students can use digital notebooks (see Pytash, 2014) or online discussion tools (see Sloan, 2014) to track their wonderings and meaning making. After creating and sharing their inquiry products, students can create think-aloud digital screencasts to reflect on their process and seek feedback from others. Reflective screencasts, like those created by students in our introductory vignette, help learners solidify conceptual knowledge across a wide range of grade levels and disciplines (Scott, 2010).

Figure 4 Connecting Knowledge-Based Learning Outcomes and Curriculum-Related Purposes for Technology Use in Personal Digital Inquiry Experiences

Knowledge-Based Learning Outcome	Curriculum-Related Purposes for Technology Use
Knowledge acquisition	*Teachers giving:* Teachers use technology to give information through direct instruction or via digital resources like text and video. Typically, students are passive participants who acquire knowledge of key content.
Knowledge building	*Teachers prompting:* Teachers use digital tools, prompting questions, and a carefully selected set of materials to prompt active engagement with content. The goal is to guide and support students toward actively building their knowledge.
Knowledge expression	*Students making:* Students use digital tools and technologies to make or create new content as a means of expressing convergent knowledge (their similar understanding of content) or divergent knowledge (their unique interpretation of content). Often, one student's knowledge product becomes part of new content for other students.
Knowledge reflection	*Students reflecting:* Students use digital tools and networked technologies to examine content learned and reflect on choices made during inquiry in order to improve the process for future action.

In summary, our PDI framework encourages teachers to consider purposes of technology use for knowledge acquisition, knowledge building, knowledge expression, and knowledge reflection. To simplify ways of thinking about how technology might be used to deepen knowledge as part of inquiry, we adapted Hammond and Manfra's (2009) three-part pedagogical model of giving, prompting, and making. From their perspective, teachers use technology according to their instructional needs. Notably, Hammond and Manfra (2009) acknowledged how these three pedagogical structures coincide with Harris and Hofer's (2009) activity type structures to suggest pedagogical stances for eliciting knowledge building and knowledge expression. Thus, in our PDI framework, we envision curriculum-related purposes of technology use paired with at least four knowledge-based learning outcomes integrated into digital inquiry practices. As shown in Figure 4, choices in inquiry-based learning can progress from teachers using technology for giving information and prompting knowledge building toward students actively using technology to make and reflect on new content.

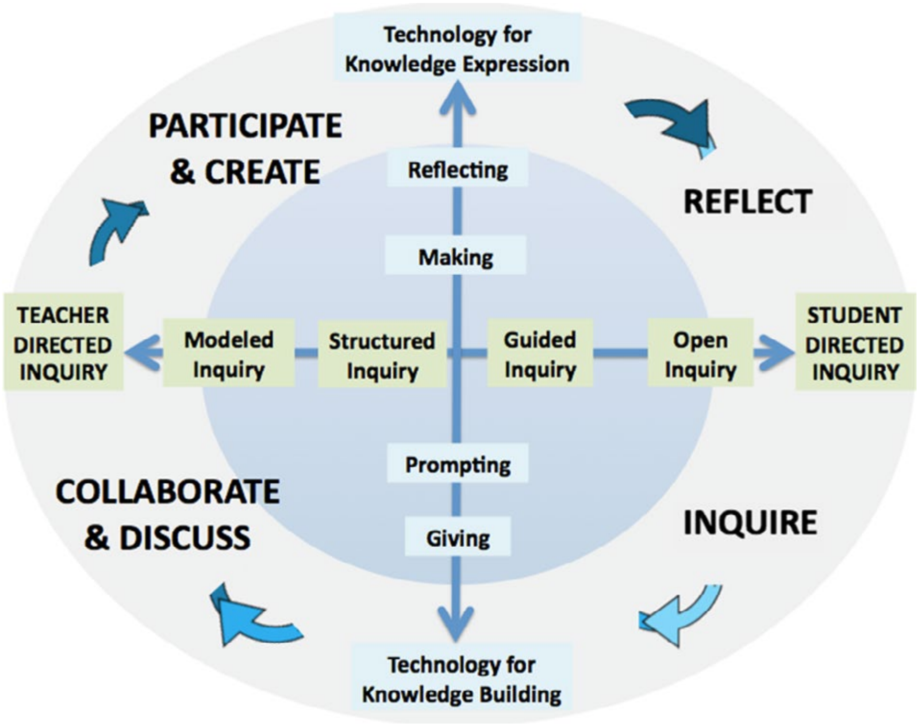
By situating ideas about supported levels of inquiry and ways of using technology in the same space, we believe the multiple dimensions of our PDI framework (see Figure 5) illustrate the complex and integral relationship between pedagogy and technology use.

What Does Teaching and Learning Look Like Within a PDI Framework?

Guided Inquiry Around the Human Body in Grades 4 and 5

This article's opening vignette illustrated how Ms. White, from North Branch, Michigan, engaged her students with Digital Wonder projects—a six-week investigation into human body systems organized within a PDI framework.

Figure 5 Personal Digital Inquiry Framework and the Integral Relationship Between Pedagogy and Technology Use



Students studied the human body as a class and were guided through personal explorations that dovetailed with the science topics they were learning. Ms. White guided her students' choices in developing inquiry topics framed by researchable (yet manageable) student-developed questions. She illustrated her expectations by sharing high-quality finished products. She also modeled efficient ways to search for relevant information, especially websites with multimedia resources designed for students. The class was guided to work in pairs to maximize discussion of content. In addition to using the Weebly website maker, students were guided in how to use Citelighter (www.citelighter.com) to highlight important information and add their personal notes to aid in meaning making.

As suggested by our PDI framework, Ms. White provided opportunities to scaffold students' independent investigations and introduced digital tools that would make the creation of their Digital Wonder projects more manageable. An overview of Ms. White's PDI planning is shown in Figure 6.

Structured Inquiry Around Plants in Grade 1

A different example of PDI illustrates the power of more structured inquiry with primary-grade children. Before students in Scarsdale, New York, began their inquiries around plants, first-grade teacher Ms. Pelekis and librarian Ms. Phillips identified key learning outcomes for their upcoming unit. Most importantly, Ms. Pelekis wanted her students to understand that a plant produces seeds so that new plants can grow. She

Figure 6 Ms. White's Personal Digital Inquiry Planning Table for Inquiry-Based Teaching and Learning in Grades 4 and 5

Digital Inquiry Project and Learning Outcomes	Inquiry Practices	Purposes of Technology Use
Guided Inquiry in Grades 4 and 5: The Human Body *Learning outcomes:* ■ Describe a health and wellness practice. ■ Identify the anatomy and physiology that surround the practice. ■ Discuss the human body system or systems involved in the practice.	*Inquire:* Describe an aspect of health and wellness that links to information about human body systems. *Collaborate and discuss:* Explore, analyze, talk about, and organize new knowledge gained from information and resources. *Participate and create:* Take notes, create interactive diagrams, collect resources, write scripts, and organize ideas to share on website. *Reflect:* Use screencasting tool to reflect on writerly choices, receive feedback from peers and parents, examine presentation and comprehensibility, and reflect on use of images, media, and text.	*Giving:* Give direction for choosing inquiry topics and searching for online content; discuss finding relevant sites. *Prompting:* Encourage examination of resources; prompt dialogue around concepts and use of new vocabulary. *Making:* Introduce Weebly and provide space for students to choose media to express their understanding. *Reflecting:* Involve students in using technologies to reflect on, revisit, and connect their work to real-world science and math contexts in ways that matter.

Figure 7 Ms. Pelekis's The Personal Digital Inquiry Planning Table for Inquiry-Based Teaching and Learning in Grade 1

Digital Inquiry Project and Learning Outcomes	Inquiry Practices	Purposes of Technology Use
Structured Inquiry in Grade 1: The Plant Cycle *Learning outcomes:* ■ Describe the plant life cycle. ■ Identify parts of a plant and functions of these parts. ■ Identify what a plant needs to grow. ■ Describe plant uses. ■ Apply plant cycle knowledge to pumpkins.	*Inquire:* Examine pumpkins in class garden and discuss individual wonderings. *Collaborate and discuss:* Explore, analyze, talk about, and organize new knowledge gained from multimedia collection of resources. *Participate and create:* Take notes, compose journal entries, draw interactive diagrams, and create digital slideshows to share with multiple audiences. *Reflect:* Describe how students learned new content, receive feedback from peers and parents, reflect on accuracy of their slideshow, and reflect on connections between plant cycle and animal cycle.	*Giving:* Give students access to safe, developmentally appropriate, content-specific digital video, images, and text. *Prompting:* Pair sets of learning prompts with a carefully scaffolded set of digital materials. *Making:* Provide digital tools and space for students to choose and make a variety of digital products that creatively express their understanding of pumpkins and the plant cycle. *Reflecting:* Involve students in using technologies to reflect on, revisit, and connect their work to real-world science and literacy contexts in ways that matter.

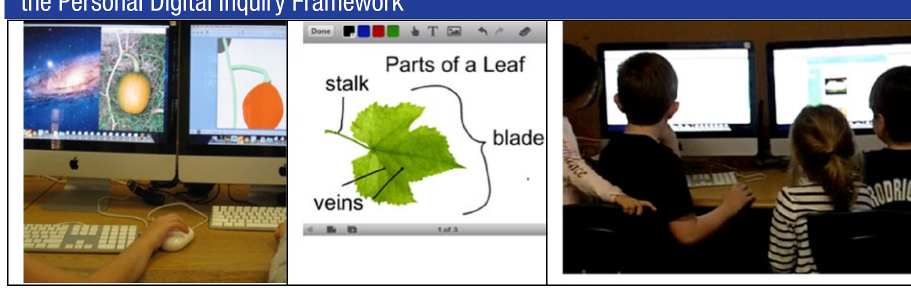
also wanted students to identify parts of a plant and understand how these parts function, explain what a plant needs, describe a plant's life cycle, and give examples of how people use plants (see more at Pelekis & Phillips, 2014).

As suggested by our PDI framework, Ms. Pelekis used these learning outcomes to inform her decisions about technology use for both teaching and learning (see Figure 7). First, she explored a range of resources to locate ones that were not only accurate and relevant to these learning goals but also safe and manageable for first graders. She compiled information from a variety of sources used in previous years and updated many of them to incorporate digital elements such as videos, informational websites, online diagrams, and interactive activities. She also selected the open-ended creativity tool Pixie (www.tech4learning.com/pixie) and a digital concept-mapping program called Kidspiration (www.inspiration.com/Kidspiration/Whats-New) for students to express and share knowledge gained from their inquiries. In this way, Ms. Pelekis planned explicit opportunities for first graders to learn science concepts while engaging in supported online research and digital response by writing and sharing digital content.

Then, Ms. Pelekis set aside four hours a week for eight weeks during reading, science, and computer time for students to complete their digital inquiry. Children's inquiries were initially sparked by questions they had while watching pumpkins grow in their school garden. With the help of Ms. Phillips, Ms. Pelekis applied a combination of giving, prompting, making, and reflecting practices to carefully structure her first graders' digital inquiry practices. She capitalized on their wonderings about pumpkins by making time to explore the rich multimodal collection of information about plants she had compiled before the unit began. Her first graders used text-to-speech applications to read challenging text, helping them understand information they could not yet read independently. Students often worked in pairs, discussing new ideas and collaboratively planning what to include in their final products (see Figure 8).

To support participation, creation, and reflection, Ms. Pelekis provided mixed media and digital tools that students used to make creative journal entries and interactive diagrams. Students also worked in pairs to create pumpkin life cycle slideshows that repeated in a loop to help them learn the concept of continuity (see one example at www.youtube.com/watch?v=wEy5UcIKlWk). At

Figure 8 First Graders Explore Resources, Collaborate, and Share Findings Within the Personal Digital Inquiry Framework



"Across the grade levels, many...teachers are discovering the power of personal inquiry in elementary school."

various times, students shared their work with classmates, teachers, and parents using bulletin boards and oral/digital presentations to showcase what they had learned. In addition, students' slideshows were stored on computers and revisited in late spring when pumpkin seeds, taken from the fall harvest, were planted. This gave students an opportunity to reflect on how well their slideshows accurately represented each stage of the pumpkin's life cycle. Later still, when the class hatched chicks, students reviewed their slideshow again and their science journals to compare and contrast a plant's life cycle with an animal's life cycle. Reflecting on their knowledge products about plants sparked questions and connections to subsequent inquiries about gardening and animals.

With the support of purposeful instruction and digital tools, Ms. Pelekis's first graders were able to investigate a range of plant topics, take notes to document and record findings, compare and contrast video observations of plant growth, and actively engage in analysis and synthesis of key concepts. When needed, Ms. Pelekis modeled necessary skills such as how to locate and navigate digital resources, how to use a text-to speech application, and how to play online videos. As a result, her first graders engaged in disciplinary thinking and meaning making while retaining concepts and making connections between their real-life school garden, their own personal wonderings, and information found online.

Across the grade levels, many other teachers are discovering the power of personal inquiry in elementary school. Although space constraints restrict us from elaborating on these examples in the printed publication, we organized a website where we briefly describe two other units and share student examples from their digital inquiries (see Figures S1–S4, which are available online as part of the Supporting Information for this article).

In both of these classrooms, you can find evidence of teachers enacting and engaging learners in the full range of digital inquiry practices while planning strategically how students will use technology to acquire, build, express, and reflect on new knowledge gained during their inquiry. In addition, each teacher provides important curriculum-based insights into how personal inquiry and online research can connect young learners in ways that matter. We intend these classroom exemplars to help anchor the PDI framework presented in this article and serve as a springboard to inspire ideas for implementation in your classroom.

Supporting Information

Additional supporting information may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/trtr.1450/suppinfo.

REFERENCES

Alberta Learning. (2004). *Focus on inquiry: A teacher's guide to implementing inquiry-based learning.* Edmonton, AB, Canada: Author.

American Institutes for Research. (2014). *Evidence of deeper learning outcomes: Findings from the study of deeper learning: Opportunities and outcomes.* Retrieved from www.air.org/resource/evidence-deeper-learning-outcomes

Belshaw, D. (2014). *The essential elements of digital literacies.* Retrieved from digitalliteraci.es/

Brown, J.S. (2005). *New learning environments for the 21st century.* Retrieved from www.johnseelybrown.com/newlearning.pdf

Bruce, B.C., & Bishop, A.P. (2008). New literacies and community inquiry. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research in new literacies* (pp. 699–742). New York, NY: Routledge.

Casey, L. (2013). Learning beyond competence to participation. *International Journal of Progressive Education, 9*(2), 45–60.

Casey, L., & Bruce, B.C. (2011). The practice profile of inquiry: Connecting digital literacy and pedagogy. *E-Learning and Digital Media, 8*(1), 76–85.

Collins, A., Brown, J.S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator, 15*(3), 6–11, 38–46.

Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The digital revolution and schooling in America.* New York, NY: Teachers College Press.

Costa, A., & Kallick, B. (2008). Learning through reflection. In A. Costa & B. Kallick (Eds.), *Learning and leading with habits of mind: 16 essential characteristics for success* (pp. 221–235). Alexandria, VA: Association for Supervision and Curriculum Development.

Dewey, J. (1997). Experience and education. In J.A. Boydston (Ed.), *John Dewey: The later works, 1938–1939* (Vol. 13, pp. 1–62). Carbondale: Southern Illinois University Press. (Original work published 1938)

Guthrie, J.T., Wigfield, A., & Perencevich, K.C. (Eds.). (2004). *Motivating reading comprehension: Concept-oriented reading instruction.* Mahwah, NJ: Erlbaum.

Hammond, T.C., & Manfra, M.M. (2009). Giving, prompting, making: Aligning technology and pedagogy within TPACK for social studies instruction. *Contemporary Issues in Technology and Teacher Education, 9*(2), 160–185.

Harris, J., & Hofer, M. (2009). Instructional planning activity types as vehicles for curriculum-based TPACK development. In C.D. Maddux (Ed.), *Research highlights in technology and teacher education 2009* (pp. 99–108). Chesapeake, VA: Society for Information Technology in Teacher Education.

Hobbs, R. (2010). *Digital and media literacy: A plan of action.* Washington, DC: Aspen Institute.

Hobbs, R. (2011). *PVK 2010: Unlitter us!* Retrieved from mediaedlab.com/2011/05/11/pvk-2010-unlitter-us/

Hobbs, R., & Moore, D.C. (2013). *Discovering media literacy: Teaching digital media and popular culture in elementary school.* Thousand Oaks, CA: Corwin.

Hull, J. (2009). *Better late than never? Examining late high school graduates.* Retrieved from www.centerforpubliceducation.org/Main-Menu/Staffingstudents/Better-late-than-never-At-a-glance/Better-Late-than-Never-Examining-late-high-school-graduates-.html

IDEO. (2012). *Design thinking for educators: Version 2.* Bronx, NY: Riverdale Country

School; Boston, MA: Author. Retrieved from www.designthinkingforeducators.com/toolkit/

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

Johnson, D. (2014). *Reading, writing, and literacy 2.0: Teaching with online texts, tools, and resources, K–8*. New York, NY: Teachers College Press.

Kühne, B. (1995). The Barkestorp Project: Investigating school library use. *School Libraries Worldwide*, *1*(1), 13–27.

Palincsar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, *1*(2), 117–175.

Papert, S. (1987). Computer criticism vs. technocentric thinking. *Educational Researcher*, *16*(1), 22–30.

Pelekis, K.A., & Phillips, C.C. (2014). Teaching digital writing in K–3. In K. Ganske (Ed.), *Write now! Empowering writers in today's K–6 classroom* (pp. 134–155). Newark, DE: International Reading Association.

Pellegrino, J.W., & Hilton, M.L. (Eds.). (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. Washington, DC: National Academies Press.

Pink, D.H. (2009). *Drive: The surprising truth about what motivates us*. New York, NY: Riverhead.

Pytash, K. E. (2014, November 7). *Using digital notebooks for modern writing students [Web log post]*. etrieved from www.literacyworldwide.org/blog/literacy-daily/2014/11/07/using-digital-notebooks-for-modern-writing-students.

Reilly, E., Jenkins, H., Felt, L.J., & Vartabedian, V. (2012). *Shall we PLAY?* Los Angeles: University of Southern California Annenberg Innovation Lab.

Schofield, C.P., & Honoré, S. (2010). Generation Y and learning. *The Ashridge Journal*, *Winter 2009–2010*, 26–32. Retrieved from www.ashridge.org.uk/Media-Library/Ashridge/PDFs/Publications/GenerationYAndLearning.pdf

Schön, D. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic.

Scott, K. (2010, March 8). *Screencasts turn students into digital teachers [Web log post]*. Retrieved from digitaldollar.edublogs.org/2010/03/08/screencasts-turn-students-into-digital-teachers/

Sloan, D. (2014, November 21). *Facilitating online discussions about text [Web log post]*. Retrieved from www.literacyworldwide.org/blog/literacy-daily/2014/11/21/facilitating-online-discussions-about-text.

Thomas, D., & Brown, J.S. (2011). *A new culture of learning: Cultivating the imagination for a world of constant change*. Lexington, KY: CreateSpace.

Wu, X., Anderson, R.C., Nguyen-Jahiel, K., & Miller, B. (2013). Enhancing motivation and engagement through collaborative discussion. *Journal of Educational Psychology*, *105*(3), 622–632.

Zhao, Y. (2012). *World-class learners: Educating creative and entrepreneurial students*. Thousand Oaks, CA: Corwin.

ONLINE ONLY SUPPORTING INFORMATION

Across the grade levels, many teachers are discovering the power of personal inquiry in elementary school. In addition to the examples offered in the printed version of our article, on this website, we feature two additional units and point you to student products resulting from their digital inquiries.

Structured Inquiry Around Climate Change in Grade 6

Ms. Kretschmar, a sixth grade teacher in Oakland, California, guided her students through a 12-week inquiry into carbon and climate change. Questions that framed their inquiry included, "What is happening? How do we know? Why do we care? What can we do about it?" To support students in understanding the science content, much of the inquiry was undertaken together as a class and was prompted by the teacher. Their inquiry began with activities that involved searching for and sorting digital images of objects that contain carbon (e.g., paraffin wax candles, sugar cane, pencils, fire extinguishers, natural gas, and diamonds). Along the way, students learned to examine photographs for evidence and interpret charts and graphs to better understand data and science concepts. They also engaged in hands-on investigations, such as examining what happens when they exhaled carbon dioxide into a solution of BTB using a straw (it turned from blue to yellow).

Coinciding with elements of design thinking (see designthinkingforeducators.com/), the unit wrap-up activity challenged students to design an object or a process that would 1) keep Earth from warming up too much, 2) keep greenhouses gasses out of the air, and 3) make the effects of climate change less harmful (see more at http://goo.gl/HMkCct). Students worked in small groups to collect information and design the presentation of their solutions using Glogster, a digital tool for creating multimedia posters. You can view their final inquiry products at http://goo.gl/wHjaTM. An overview of Ms. Ketchmer's PDI planning is shown in Figure 9. Figure 10 depicts a screenshot of one group's creative solution for how to use white paint to slow the effects of global warming on a glacier.

Digital Inquiry Project and Learning Outcomes	**Inquiry Practices**	**Purpose of Technology Use**
Structured Inquiry in Grade 6 – Climate Change *Learning Outcomes:* • Understand and represent the carbon cycle • Interpret data and collect evidence from text to determine that the global climate is changing • Design a solution that would combat climate change	*Inquire:* Examine images and search for information to determine which everyday objects contain carbon *Collaborate & Discuss:* Explore, analyze, talk about, and organize new knowledge gained from graphs, photographs, informational websites, and hands-experiments *Participate & Create:* Take notes, create carbon flow diagrams and design multimodal posters to share their solution to the design challenge with peers and teachers *Reflect:* Showcase their work to their peers to collect feedback on their ideas. Refine their idea using suggestions from their peers and teacher. Provide additional background information to demonstrate how their solution would combat climate change	*Giving*: Give students access to accurate and relevant multimodal websites using Google Custom Search *Prompting*: Pair sets of learning prompts with a digital annotation tool (Citelighter) to collect and archive ideas in small groups of three students *Making*: Provide digital tools (e.g., Glogster and MindMeister) and give students space to conduct online research to come up with an idea. Create digital products that creatively express their understanding of how to reduce harmful effects of climate change *Reflecting*: Involve students in using technologies to reflect and apply their work to real world environmental issues and make connections to their community in ways that matter

Figure 9. Ms. Kretschmar's PDI Planning Table for Inquiry Based-Teaching and Learning in Grade 6

Figure 10. A screenshot of one group's Glogster Design Challenge Solution
to slow glacial melting by painting the Andes Mountains white

Guided Inquiry Around Media Literacy and Video Production in Grades 4-5

Students at The Academy of Talented Scholars in Brooklyn, New York (see taots.org/) produced a series of documentary videos collaboratively scripted across three classes to share their perspectives on their school. Facilitated by Rhys Daunic, a media literacy expert from The Media Spot (see themediaspot.org/), the grade-wide collaborative project began at the end of students' 4th grade year and continued into their 5th grade. Rhys worked with Principal Josephine Sportella-Giusto to provide the students a framework that would generate videos that fit the communications needs of the school. Scripts for these films started as personal essay responses to various prompts with a thesis, three supporting opinions, and a conclusion. Small groups of students engaged in close reading practices to find common themes across their writing, which were collected on an online mind map using Mindmeister (www.mindmeister.com/).

Each group was responsible for planning and producing a short documentary on the emerging themes to express opinions of their school and provide evidence supporting those claims. Students worked collaboratively to apply critical reading and media literacy skills, analyze themes, conduct interviews, plan storyboards, record and edit video, and perform narration as voiceovers. Their final work was shared with not only with their peers and teachers, but also with prospective parents and students. You can find a detailed overview of the project and student examples at http://goo.gl/NSm45q. Figure 11 outlines how decisions about technology use for both inquiry-based teaching and learning aligned with learning outcomes focused on both media literacy and the genre of documentary video. You can view a reflective video that documented the whole process by clicking on the image in Figure 12.

(see images and links on next two pages)

Digital Inquiry Project and Learning Outcomes	**Inquiry Practices**	**Purpose of Technology Use**
Guided Inquiry in Grades 4/5 – Media Literacy and Video Documentaries *Learning Outcomes:* • Analyze the quality and credibility of messages, while considering potential effects of consequences of messages • Determine, analyze, and summarize key ideas or themes • Assess how point of view or purpose shapes content and style of a text • Write informative or explanatory texts • Compose or generate content using creativity and confidence in self-expression	*Inquire:* View documentary film clips and generate ideas about techniques that filmmakers use to tell stories, create tone, and express their point of view *Collaborate & Discuss:* Student production teams analyze essays, identify themes to organize and discuss how to synthesize common ideas into a script *Participate & Create:* Translate writing into storyboards; make documentary videos with voiceover narration to share with prospective parents and students *Reflect:* Share videos with multiple audiences and reflect on their ability to create the intended effect on each audience; create a “Document This” video to document their learning process throughout the unit	*Giving*: Give students access to a range of documentary film clips and storyboarding techniques at different stages of the inquiry process *Prompting*: Pair sets of learning prompts with a argumentation structures and a collaborative concept mapping tool (Mindmeister) to help production teams brainstorm and organize ideas from essays, interviews, and scripts *Making*: Provide digital video composition tools (e.g., iPads, flip cameras, video editing software) and give students choice in crafting persuasive multimedia products to best represent their collective points of view *Reflecting*: Involve students in using technologies to reflect on and apply their work to real world marketing techniques for use in their community

Mr. Daunic’s PDI Planning Table for Inquiry Based-Teaching and Learning in Grades 4/5

Figure 12. View the “Document This!” process video created by teachers and students at the The Academy of Talented Scholars (TAOTS) in Brooklyn, New York at http:/vimeo.com/84688866