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Crosswalk between the *Framework for K–12 Science Education* and *Standards for the 21st-Century Learner*: School Librarians as the Crucial Link

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Abstract

*Within the school library community, there have been persuasive calls for school librarians to contribute to science learning. We present a conceptual framework that links national standards of science education (*Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, referred to as* "Framework"*) to core elements embedded in AASL's* Standards for the 21st-Century Learner *(referred to as* "Standards"*), the standard that guides the teaching and learning of multiple literacies for which librarians are responsible in schools. Based on this conceptual framework, we highlight how four middle school librarians in a large school district in the mid-Atlantic region of the United States enact and expand their five roles—information specialist, instructional partner, teacher, program administrator, and leader—while they participate in Sci-Dentity, a science-infused after-school program. We observed clear links between skills, dispositions, and responsibilities from the* Standards*, taught and facilitated by these school librarians, to principles in the* Framework*. We contend that the learning of the*

Standards *is crucial to creating and sustaining science-learning environments as envisioned in the* Framework *and argue that school librarians' role in science learning is more vital than it has ever been.*

Introduction

School librarians wear many hats; among them are five that the American Association of School Librarians (AASL) designates as official roles school librarians play in schools: information specialist, instructional partner, program administrator, teacher, and leader (AASL 2009a). Figure 1 summarizes the responsibilities that these roles prescribe to school librarians.

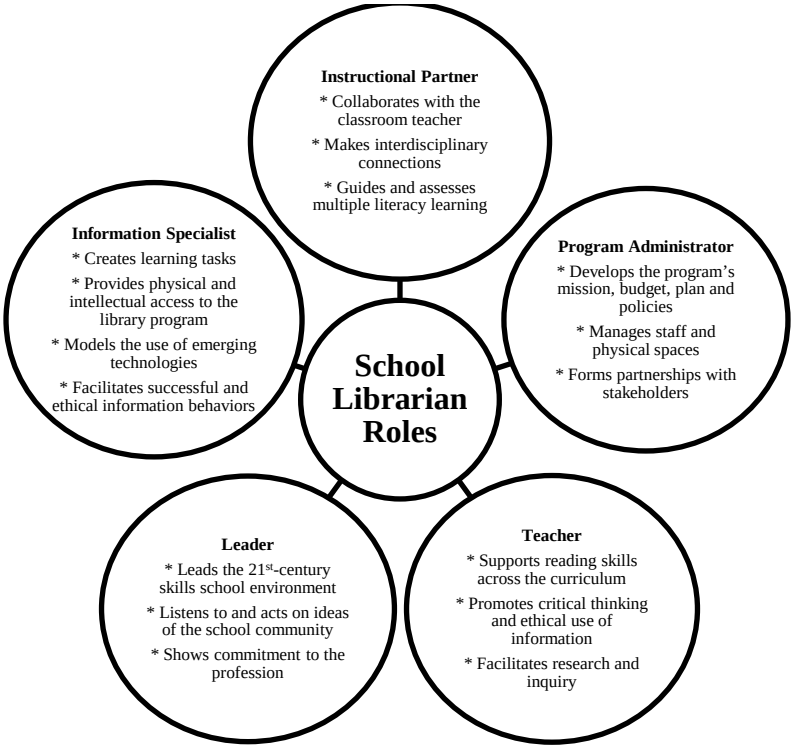

Figure 1. Roles of school librarians.

By fulfilling these roles in schools, school librarians have been successful in demonstrating their contribution to student achievement. Recent studies show the value of school librarians in student learning, specifically in terms of promoting reading in early childhood, increasing teacher involvement and effectiveness, and contributing to higher graduation rates for at-risk students (New York Comprehensive Center 2011), as well as leading the charge for technology integration in schools (Scholastic Research and Results 2008). Scholarly research also shows clear correlations between school libraries and improved scores on standardized tests (Bailey and Paul 2012; DiScala and Subramaniam 2011; Francis and Lance 2011; Lance, Rodney, and Hamilton-Pennell 2000; 2001; 2002; 2005; Lance and Russell 2004; Library Research Service 2011). Researchers have called for increased study of the contributions that school librarians make to schools (Neuman 2003).

In this era, in which science, technology, engineering, and mathematics (STEM) education have a high priority, there have been persuasive calls that school librarians must and should enact all of these above-mentioned roles in science and mathematics learning (Fries-Gaither 2010; Mardis and Howe 2010; Subramaniam et al. 2012). However, such appeals have not been accompanied or informed by research on how school librarians can function in these roles within the framework of STEM learning in schools. In this paper, we begin such research by exploring the pertinent roles that school librarians can play in science learning and by describing the unique contributions that they can make to young people's learning of science. Working from the *Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council 2012), which emphasizes the inquiry process, the importance of making connections to the diversity that young people bring to classrooms, the need to make connections to their interests, and the substantial role of socialization in science learning, we see links between the science-education framework and the core elements embedded in the *Standards for the 21st-Century Learner* (AASL 2007). School librarians are now responsible for ensuring that young people have the skills, dispositions, and responsibilities to select, use, create, organize, distribute, and evaluate information as indicated in the *Standards for the 21st-Century Learner in Action* (2009b). We believe, more than ever, this is the perfect time to engage school librarians to link these skills to science learning.

We begin with a presentation of the sociocultural approach to science learning as outlined in the *Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (from now on referred to as "*Framework"*) and recent research in science learning. We then make connections between this approach to science learning and AASL's *Standards for the 21st-Century Learner* (from now on referred to as "*Standards")*, the standards that school librarians are responsible to teach and facilitate in schools. We argue that librarians' roles and the skills that they impart are critical for science learning. We then present a study of the implementation of a science-infused after-school program, Sci-Dentity, which we co-designed and co-implemented with public middle school librarians in a large school district in the mid-Atlantic region.

In this exploratory study, we highlight how school librarians enact these five roles—information specialist, instructional partner, teacher, program administrator, and leader—and their contributions while they participate in Sci-Dentity. We share the standards, skills, dispositions, and responsibilities from the *Standards* that were taught to or facilitated for young people participating in this program and show how these standards, skills, dispositions, and responsibilities are aligned with the *Framework*. This study contributes new understanding of how school librarians' roles, as well as the skills, dispositions, and responsibilities that they are responsible for teaching and facilitating in schools, are critical to the creation and sustainability of science-learning environments as envisioned in the *Framework.*

It is our hope that, based on the results from this study, science educators, administrators, and researchers will engage school librarians in designing and implementing science-infused educational programs in schools.

Conceptual Framework

National Framework of K–12 Science Education

The *Framework* for science education asserts the following tenets (among many) that should be embraced when designing science-learning environments:

- **Young people and children are born investigators**—As a result of interaction with their surroundings, children and young people learn about the world, develop ideas, engage in inquiry, and continue to build their conceptions and refine their (mis)conceptions to make sense of the phenomena around them.
- **Learning must connect to students' interests and experiences**—Research suggests that young people's personal interest, experience, and enthusiasm is linked to later educational and career choices; "in order for students to develop a sustained attraction to science and for them to appreciate the many ways in which it is pertinent to their daily lives, classroom learning experiences in science need to connect with their own interests and experiences" (National Research Council 2012, 28).
- **Embrace diversity as a means to enhance learning science**—In the United States there is increased awareness that the nation is becoming more diverse and that broadening participation in science is crucial. It is expected that these diverse communities can bring diverse customs and orientations to science-learning environments; as a result, the learning process and the community within which students are situated will be enriched.
- "**Science is fundamentally a social enterprise and scientific knowledge advances through collaboration and in the context of social system with well-developed norms**" (National Research Council 2012, 27)—Often, strong theories and models are developed collectively by a group of scientists. Scientists also frequently exchange ideas via collaborations, presentations, writings, and discussions. Being aware of the well-developed norms of sharing artifacts/data, building on artifacts/data produced by others, observing copyright, and providing attribution will boost the creation of a strong scientific community.

Working within this *Framework,* we contend that school librarians have clear opportunities to participate in science instruction because of the *Framework's* emphasis on a sociocultural approach to science learning. A sociocultural perspective recognizes that science learning involves more than merely understanding facts, but also values learners' personal backgrounds and encourages deeper notions of scientific practice and inquiry. The National Research Council (2012) recommends that science education be built around dimensions that underscore the integration of core ideas in scientific disciplines with opportunities for students to engage in interdisciplinary experiences and applications of science throughout their educations.

As articulated in the *Framework,* true science learning moves beyond merely applying factual knowledge to known problems. Current research illustrates that students' life experiences and backgrounds significantly impact their science-learning modalities. Students' experiences of science-learning environments can be in either conflict or coalescence with their personal backgrounds, interests, and identities (Barton, Tan, and Rivet 2008; Barton and Tan 2010; Polman and Miller 2010). As a result, learning-scientists and science-education researchers are increasingly interested in developing educational experiences that will foster coalescence. To do this, they seek to design environments and curricula that foster (a) authentic, social inquiry practices, (b) leverage the everyday interests of students, and (c) use students' identities and personal experiences as touchstones in their science learning (Chinn and Malhotra 2002; Clegg, Gardner, and Kolodner 2010). One way to accomplish this task is to incorporate science learning into activities with which students are already familiar. Tamara L. Clegg, Christina M. Gardner, and Janet L. Kolodner (2010) developed a learning program that uses cooking, a life skill even young children are aware of, to introduce scientific-inquiry practices. As children worked to develop their recipes based on their own food interests, they engaged in authentic inquiry and

changed their self-conceptions to view themselves increasingly as cooks and scientists. Similarly, Joseph L. Polman et al. (2012) engaged young people to be translators of science information for the general public through their *Science Literacy through Science Journalism* (SciJourn) project, in which these young people view themselves as science journalists and gatekeepers to scientific information that may be of interest to the public.

The *Framework's* principles emphasize young people's relationship with science in terms of everyday life, particularly how they use natural investigative strategies in navigating their worlds. Instructional strategies should embrace this innate curiosity and connect students' own interests and experiences with what is occurring in the school. Deep scientific practice also involves skills such as adopting norms of a scientific community and communicating one's ideas within the norms of that community or other relevant communities (Ford and Forman 2006).

Potential Roles of School Librarians in Science Learning—Linking the *Standards* to the *Framework*

In schools, librarians are the personnel designated to facilitate the mastery of the *Standards*. "The *Standards* lay out underlying common beliefs, as well as standards and indicators for essential skills, dispositions, responsibilities, and self-assessment strategies for all learners" (AASL 2009b, 5). The *Standards* document lists nine common beliefs that are woven into the standards, skills, dispositions, and responsibilities detailed in this document. Two of these beliefs serve as the core focus of school library programs: reading serves as a foundational skill for learning (belief 1), and inquiry skills, dispositions, and responsibilities provide a framework for learners to thrive in complex learning environments (belief 2). The following skills are believed to be essential in the selection, use, creation, and evaluation of information: ethical decision making, effective use of technology, information literacy, and critical thinking (belief 3, 4, 6, 7). Learners must also have equitable access to resources and opportunities to learn (belief 5). Sharing and learning from others is completely necessary in the current information environment, which dictates that learning is enhanced by having a social context (belief 8); finally, each school must have a vibrant school library program in which the above-mentioned beliefs are embedded (belief 9). The principles of inquiry, equity, social context, and making connections to student interests and experiences that were discussed in the *Framework* above are evident in the beliefs of the *Standards.* (See the section above on *National Framework of K–12 Science Education).*

In AASL's *Standards*, student objectives/outcomes are organized under four main standards. Standard 1 calls for students to "inquire, think critically, and gain knowledge" (AASL 2007, 4). Standard 2 is centered on students "draw[ing] conclusions, mak[ing] informed decisions, apply[ing] knowledge to new situations, and creat[ing] new knowledge" (AASL 2007, 5). Standard 3 invites students to "share knowledge and participate ethically and productively as members of our democratic society," while standard 4 calls for students to "pursue personal and aesthetic growth" (AASL 2007, 7).

Within each of these standards, AASL has outlined skills, dispositions, responsibilities, and self-assessment strategies that 21st-century learners should possess.[1] The responsibilities encourage

[1] The organization of the skills, dispositions, responsibilities, and self-assessments is by a numbering convention that follows *n1.n2.n3*. The first number (*n1*) is the standard number (1 through 4); the second number (*n2*) refers to the type of classification within the standard (1 = Skills; 2 = Dispositions in Action; 3 = Responsibilities; 4 = Self-Assessment Strategies). Finally, the third number (*n3*) refers to the sequential position of each objective/outcome within the second grouping.

students to take information in the context of the global learning environment and to consider their actions in terms of what is ethically correct. The dispositions are learner actions that show their understanding of the standards. Appendix A contains the complete list of standards, skills, dispositions, responsibilities, and self-assessment strategies as stipulated in the *Standards*.

We observe clear links between the *Standards* (including the dispositions, responsibilities, and skills that are found within them), and the principles found in the *Framework*. Each of the standards uphold the sociocultural components that enhance science learning as discussed above. Appendix B details the crosswalk between the four principles found in the *Framework* and the *Standards.*

Viewed through the sociocultural lens, the connection between the school library program and science education can be deep, but requires new thinking about how librarians can play a role in science learning. We transformed the above conceptual frameworks into practice by designing and creating Sci-Dentity, an after-school, science-infused program implemented in school libraries. In this program for middle school students, we collaborated with school librarians to facilitate the students' acquisition of skills, responsibilities, and dispositions associated with the *Standards* and created an environment that inherently contributed to the development of socioculturally relevant learning that will encourage science interest and science learning among participating middle school students.

Context

Introduction to Sci-Dentity

Sci-Dentity is an after-school program for urban middle school students in a major metropolitan area in the mid-Atlantic region of the United States. Sessions meet weekly and are co-designed and co-implemented with four participating middle school librarians. Three of the librarians are certified school librarians, and one librarian was working on her certification at the time we began this project. Through Sci-Dentity the students are encouraged to engage with science and science-infused media in a variety of formats. Students read science fiction, graphic novels, and popular-science articles and books; watch science fiction movies; and play computer and video games that incorporate science in the games' themes, narratives, or structures. During each session, students are asked to imagine the science connection in the materials they consume and to make connections to their prior knowledge.

In collaboration with the school librarians and the students, high-interest topics are identified for exploration: for example, natural disasters, superheroes, or technological innovations. At each session, students are prompted to make connections between the fictional narratives they read or view and the factual information they glean through inquiry and prior knowledge and then extend that knowledge through the creation of their own fictional narratives. Within a private online community (social-media site) created for this project <www.sci-dentity.org>, students both share their stories and comment on others' work. Throughout the sessions, students are actively encouraged to use the site for writing, exploration, and commenting outside of the formal meeting time. The site was created and is continually revised in collaboration with students and librarians to ensure that it meets their needs. School librarians and researchers work collaboratively to investigate the impact of science-infused media on students' self-conception and engagement with science.

Information about Sci-Dentity was distributed to all sixth graders in the selected schools, and interested sixth graders were asked to contact the school librarians to participate in the program. The school librarians distributed the consent forms to parents of interested students (as stipulated by the internal review board at the University of Maryland and the school district). The program's first semester ran from February 2012 to May 2012 and served approximately fifty-seven sixth-graders (aged eleven and twelve). Minority representation was high, and gender distribution was balanced. Thirty-nine of these students completed demographic surveys for the researchers. In this sample of students, seventeen (43.6 percent) are male and twenty-two (56.4 percent) are female. In terms of ethnicity, twenty-two (56.4 percent) self-identify as African American, three (7.6 perent) as Latino/Hispanic, four (10.2 percent) as white, four (10.2 percent) as multiracial, five (12.8 percent) as "Other", and one (2.6 percent) did not respond. Three of the four schools were in the process of mandated restructuring due to missing targets for Annual Yearly Progress (AYP), and all schools had a high percentage of students (57–77 percent) receiving Free and Reduced Meals (FARMs). These missed AYP targets and FARM-eligible students are key indicators of high poverty levels and low academic performance.

Activities with the School Librarians

The researchers and school librarians used a method known as cooperative inquiry (Druin 1999, 2005; Guha et al. 2005) to co-plan the sessions and develop the site. Working with the librarians and their district's manager for library media services, the researchers engaged in two co-design sessions, one prior to the start of the program in the schools and one at the end of the first semester's implementation of the program. During these co-design sessions, researchers and librarians planned the website, formalized abstract ideas, and identified resonant themes. In addition to these sessions, regular informal debriefings occurred at the end of each after-school session and through e-mail when needed.

At the first co-design session in January 2012, school librarians and researchers collaborated to identify resonant topics and themes for each after-school session. The co-design process included brainstorming activities such as collaborative mind maps to choose after-school session topics, anonymous sticky-note exercises to solicit feedback and design ideas for the site, and free-ranging, open dialogs about the experience. These themes were refined to reflect current topics in the science curriculum so as to provide maximum opportunities to make connections and create opportunities for writing and media-infused storytelling (creating comics, digital picture books, etc.). In the second co-design session (May 2012), we reflected on the prior semester and engaged the school librarians in a brainstorming process to develop rich topics and media for the next semester. Both design sessions were audio- or video-recorded, and all artifacts were retained and documented.

At every co-design and informal debriefing, we collaboratively reflected on ways to strengthen the program's activities and to ensure we were meeting the goals of the program. Finally, all research-team members engaged in reflection that is shared with the team through an internal memoing process. All participating librarians were interviewed at the end of the session to probe their experiences more deeply. The interviews were semi-structured and were conducted onsite at the participating schools.

Purpose and Research Questions

The overarching goal of this study is to discover how school librarians can play an active and stronger role in advancing science learning among young people through the various roles that school librarians typically play in schools and through the facilitation of learning of the *Standards* that are relevant to the *Framework*. Using Sci-Dentity as a context, we examined the following exploratory questions:

1. How did these school librarians function as information specialist, instructional partner, teacher, program administrator, and leader?
2. How did these school librarians facilitate the learning of standards, skills, dispositions, and responsibilities, as indicated in the *Standards*, that are relevant to the *Framework*?

Methodology

Our approach to this study is heavily informed by the design-based research (DBR) model (Collins, Joseph, and Bielaczyc 2004). In DBR researchers and educators co-design educational programs, technologies, and environments and then continually refine and revise these aspects over time. The design is iterative; data are collected continuously and used to make ongoing improvements for the benefit of the students engaged in the program. It is important to note that the students themselves are key players in the ongoing refinement of this DBR study. For example, as students discovered features of the social-media site, they often requested changes that were incorporated wherever possible. Likewise, as they expressed interest in different topics or storytelling modalities, those were also incorporated.

This DBR method was selected for several reasons. First, we are interested in the role of school librarians and believe that by engaging them as co-designers, we can better examine their roles. For example, drawing on the librarians' knowledge of student interest, we developed a lesson on dystopias timed to coincide with the (at that time) soon-to-be-released movie *The Hunger Games*. Second, using DBR allows us to maximize the benefit to participating students by making needed changes immediately and to increase their engagement by encouraging their participation. Finally, DBR encourages articulation and testing of our conceptual framework: linking the *Standards* to the *Framework*, which is absolutely vital to our commitment to highlight the roles that school librarians play in creating rich science-learning environments. DBR has been an essential component of the deep exploration of the learning process; DBR has the additional benefit of ensuring that successful strategies are strengthened and less successful strategies are minimized or abandoned.

Data Collection and Analysis

To answer the research questions for this study, the research team captured the following data through ethnographic methodologies: (1) artifacts produced in the co-design sessions; (2) transcriptions of the two co-design sessions; (3) internal memos that were kept by the members of the research team to document changes made to the after-school sessions and the site and to record their observations during the after-school sessions; and (4) transcriptions of the individual interviews with the four librarians conducted at the end of the first semester of Sci-Dentity. Whenever needed, we include the students' stories to demonstrate and articulate the roles the librarians play in science learning and their ability to facilitate the learning of *Standards* relevant to the *Framework*. In the findings below, we refer to the librarians (who participated in the co-design sessions) using their pseudonyms: Grant, Amy, Leslie, and Nancy.

The research team began data analysis by practicing open coding on one of the transcripts of interviews with librarians. Each team member developed a personal codebook based on the research questions. By triangulating and juxtaposing these individual codebooks, the research team identified themes, enabling the formation of a group codebook. Researchers coded another set of transcripts using this group codebook, discussed, made further revisions to the codes and created a final version of the codebook. The codebook was entered into Dedoose.com, a qualitative data-analysis software system. The findings discussed below were drawn from the themes and passages that emerged during the coding process.

Findings and Discussion

School Librarians as Information Specialists, Instructional Partners, Teachers, Program Administrators, and Leaders in Science-Learning Environments

In Sci-Dentity's first semester, the participating school librarians found ways to show multiple examples of being information specialists, instructional partners, teachers, program administrators, and leaders in facilitating science learning. Below we discuss how the librarians function in each of the five roles while leading Sci-Dentity in their respective schools.

Information Specialist—While students participated in Sci-Dentity, they increased their use of librarians as guides to finding science resources; this reliance on school librarians highlights the role of librarian as information specialist. For example, Nancy described Sci-Dentity participants' increased interest in scientific subjects, resulting in her students' showing more interest in the science books in the catalog. One student was particularly interested in dinosaurs, which were featured in his story, so Nancy was able to identify relevant books in the collection. Another librarian, Grant, sensing his students' interest in science fiction books, but lacking a robust collection in his library, supplemented his collection with materials from the public library.

Through the interviews with librarians and the observation notes, we discovered that the librarians went beyond assisting students in finding, assessing, and using information; we identified instances of librarians introducing and modeling the use of technology in science learning. This use of technology included identifying Web and electronic resources that are appealing to young people. Examples of these resources are BrainPOP and iPad apps for finding science facts or problems that connect to learners' personal interests and experiences. Through close examination of the challenges that some of these students face in writing their stories, school librarians recognized that technology could help students more easily compose stories. Therefore, during the co-design sessions, the librarians suggested the use of technology such as Dragon NaturallySpeaking speech-recognition software, and/or use of video-based storytelling that would allow students to focus more on their science storytelling in Sci-Dentity than on the actual writing process. In the current (second) year's implementation of Sci-Dentity, the research team and the librarians are encouraging students to audio- or video-record their stories, instead of writing their stories, to ensure that the students remain motivated to share their science stories.

Instructional Partner—The instructional partner role of these four school librarians participating in science learning is defined best by the actions of collaboration with the researchers and current or potential collaboration with science teachers. Through participation in Sci-Dentity, science teachers are becoming more aware of the potential values and strengths of

the librarian as instructional partner in their building. Grant mentioned that one of the science teachers at his school has shown "overwhelming support" for Sci-Dentity, allowing Grant to "collaborate with the students, during the science times in their classroom…[talking] about some of the things [they] do in Sci-Dentity, and talk about [their] stories, and try to get them to write more." At another middle school, Leslie worked with the sixth-grade science teacher and believes that Sci-Dentity has prompted the opportunity for additional collaboration next year. One additional element of the instructional partnership role is the librarians' knowledge of the science curriculum, knowledge that we leveraged in the design of Sci-Dentity sessions. Throughout the Sci-Dentity instructional-design process, these four librarians showed their understanding of where the students are in their science education by being able to articulate the suitability for sixth-graders of after-school sessions' themes and topics. For example, we originally intended to have a session on the Schrodinger cat's experiment, bringing the concepts of physics and infinite multiverse to these sixth graders. However, the librarians clearly indicated that the students would not be able to connect with such high-level science concepts. Instead, the librarians identified topics related to natural disasters, such as tornados, floods, volcanic eruptions, and earthquakes, as being suitable topics for the after-school sessions as these topics correlate with the sixth-grade science curriculum and students will be able to relate to these topics.

Teacher—School librarians play the role of teacher of information-literacy, technology, critical-thinking, and ethical skills to young people. In Sci-Dentity the librarians facilitated such learning through provision of guided instruction (such as prompts, questions, etc.) that assisted students to master these skills. For example, in a co-design session, the librarians came up with the following prompt for story writing for a session on tornados: *You are a storm chaser headed toward the biggest, baddest F5 tornado. Who is in the car with you? What tools do you have? Do you keep going? What happens when you get inside the storm?* In answering these guiding questions, the students have to be able to search and assess information about tornados and scientists who chase storms (apply information-literacy skills) and describe the situation of being in a storm by examining the scientific facts of tornados (apply critical-thinking skills). As students write their stories, they have to make sure that they cite their resources (demonstrate ethics) and be able to share them in the Sci-Dentity site (apply technology skills). Whenever possible, the librarians facilitated the students' learning of these skills in the after-school sessions.

Program Administrator—In their role as program administrator, school librarians typically ensure that resources and technology are available to all students and meet the variety of their needs and interests. Leveraging the librarians' knowledge of the needs of students, we engaged the librarians in designing the features of the Sci-Dentity site to ensure availability of tools and resources that will engage the students in writing their science stories on the site. During the Sci-Dentity design sessions, the librarians suggested multiple features of story-writing assistance that can be made available on the site such as the use of emoticons, comics, sound effects, and picture galleries. As mentioned previously, the librarians envisioned students writing stories in alternate formats such as audio stories, graphic novels, and video presentations, as these are the formats that these students currently enjoy reading, viewing, and listening to. We intend to build such features on the site and allow creation of science stories in alternate formats. Similarly, we envision that science teachers can leverage the librarian's knowledge of students' needs, interests, and access to resources when the teachers design their curriculum, science projects, science fairs, or science-oriented clubs and activities.

Leader—Functioning in the four roles above encouraged the librarians to begin seeing themselves as leaders or pioneers in science programming at their respective schools. Some of the librarians also mentioned aspirations they had for innovative programs in their schools; one librarian suggested she would like to bring aspects of this program to summer school, and another wanted to emphasize elements of the program in clubs or evening activities, such as "STEM nights." During the interviews at the end of the first semester, the librarians revealed that their involvement in science learning is now being "noticed" through their participation in Sci-Dentity and that the science teachers are seeing the school librarians as potential contributors to science learning.

Co-designing and co-implementing Sci-Dentity with the school librarians have highlighted the use of librarians in science learning in the four roles (information specialist, instructional partner, teacher, and program administrator) mentioned above, and have inspired the librarians to continue functioning in these roles to become a leader in science learning in their schools (outside of Sci-Dentity).

Facilitating Learning of the *Standards* in Sci-Dentity

Earlier, in the "Conceptual Framework" section, we identified the skills, dispositions, and responsibilities in the *Standards* that are linked to the sociocultural *Framework* for learning science presented earlier (see crosswalk in Appendix B). The school librarians facilitated the practice and learning of many of these relevant skills, dispositions, and responsibilities to create the sociocultural learning environment envisioned in Sci-Dentity. The ideas and suggestions that came from the librarians were implemented in the first semester, and some will be further facilitated in the upcoming semesters. In our examination of all the data sources mentioned in the "Data Collection and Analysis" subsection, we looked for evidence of the teaching or facilitation of these identified skills, dispositions, and responsibilities. Numerous skills, dispositions, and responsibilities as indicated in Appendix B were facilitated; however, in this discussion we chose to highlight those with the strongest presence.

Framework Principle One: Young People and Children Are Born Investigators.

School librarians have tremendous ability to facilitate an inquiry-based process that helps students make real-world connections for using the process in and outside of the classroom and allows the development and refinement of a range of questions to frame searches (see skills 1.1.1 and 1.1.3 in Appendix A). For example, librarians responded positively to our suggestion that we run a Sci-Dentity session on how to create public service announcements (PSAs) focusing specifically on local environmental issues, such as pollution in the Anacostia Waterway, a local river and its associated watershed. The waterway's close proximity to where these students reside emphasizes making connections to the real world. Amy emphasized the importance of background knowledge (knowledge about plants' and animals' habitats), finding the appropriate resources (local news reports and video) to begin writing a PSA, and the need to develop a range of questions to create a PSA, questions such as "What is a PSA?" "Who is the intended audience for the PSA?" "What information should be included?" We have not yet implemented this session due to time constraints, but may create a session centered on these questions in the future.

To bolster the students' connection to science, Grant suggested including a literary-response activity in Sci-Dentity to allow these students to make sense of the science information that they have gathered. Such an activity would help the students identify main and supporting ideas, conflicting information, and points of view or biases (skill 1.1.7, Appendix A). In an interview with Grant, he shared:

> ...one in particular is something called literary-response activity, and that is, I will give them articles about science, it may be a current event focusing on science, and they have to respond to the science, the STEMs, so it may say… "in my opinion I did not like it when the article…," "my favorite part of the article was…", "I think the best way that the article could've been written was [making sense of the information]." So it's really trying to stretch students to a higher level of thinking, particularly critical thinking.

Standard 2 advances the process of inquiry a step further by encouraging students to "Draw conclusions, make informed decisions, apply knowledge to new situations, and create new knowledge" (AASL 2007, 5). The school librarians assisted the research team in designing sessions that delve deeper into the inquiry of science by applying critical-thinking skills to construct new understandings that are relevant to these students' interests. For example, one of the sessions co-designed with the librarians was a session on "storm chasers" (scientists who track tornados). Students were shown a storm-chaser video and led in a discussion of the role of storm chasers, the technology they use, and the dangers they face. Students were then prompted to take on the role of storm chaser and write short stories from the perspective of the scientist/storm chaser, incorporating the technology they would use and the choices they would make. Such an activity encourages these students to extend the inquiry process by applying critical-thinking skills to construct new knowledge and understandings about storm chasers and sharing the stories (see skills 2.1.1 and 3.1.1 in Appendix A). To further enhance the science connections students could make to their stories, the librarians also suggested the use of graphic organizers, process tools containing prompts to define characters and the science facts.

In terms of dispositions, because Sci-Dentity is a voluntary, after-school, quasi-academic program, students who participate have already demonstrated that they are motivated to seek information to answer personal questions and interests, try a variety of formats and genres, and display a willingness to go beyond academic requirements (disposition 4.2.2 in Appendix A). In addition to going above and beyond "academic requirements," the disposition expresses the expectation that students will engage in a variety of formats and genres. Several students produced their stories in nontraditional formats including use of the iPad Story Kit app to produce a picture book, use of the Comic Life app to create graphic novels, and the creative repurposing of PowerPoint to create picture books of their stories. The disposition suggests that students benefit from a diversity of formats in seeking and sharing information; Sci-Dentity participants amply demonstrate this disposition during the research process in which they engage to complete their stories and by means of the variety of story formats that they have produced. The librarians assisted in this process.

Framework Principle Two: Learning Must Connect to Students' Interests and Experiences.

One of the compelling reasons we leveraged the expertise of the school librarians is because we wanted to obtain their feedback in connecting the process of learning science to community issues (skill 3.1.5 in Appendix A) in which students were interested. During a mind-mapping

activity that we conducted during the design sessions, the librarians helped us tremendously in this process by identifying topics that would be appealing to students. Among the topics that the librarians identified were natural disasters such as earthquakes and volcanic eruptions, severe weather such as tornados and floods, the solar system, time travel and new technologies, superheroes, computer games, and epic tales. From this list, we have implemented the following topics thus far: storm chasers (severe weather and technology) and utopia/dystopia (epic tales about the future).

School librarians also know about students' everyday-life interests, such as the books students read, the music they listen to, the movies they watch, and the games they play. Librarians typically keep themselves abreast of trends in young adult literature and of technology developments that allow them to connect these young people to resources that can bridge between in-school and out-of-school contexts (AASL 2010; YALSA 2011). In both design sessions, the librarians talked about students' interest in superheroes. During the first co-design session, librarians conveyed that students (both male and female) are fascinated with superheroes and related special abilities. Similarly, we observed that many students' stories depict characters with advanced abilities or are based around the mythos of a superhero universe. As this theme is rich with possibilities for scientific exploration, superheroes are now the theme for this year's Sci-Dentity sessions. Possible topics as identified in the final design session include: the science behind the design of superheroes' costumes or gadgets; the science behind superheroes, exploring what is and is not possible; and real-life superheroes, such as rescue personnel.

Since students' stories are shared on the social-media site, librarians were able to engage their students in use of the site to write stories that connect to the authors' and readers' own interests (skill 4.1.5 in Appendix A).

We observed that many of the boys were deeply engaged in a few online games. Leveraging that interest led to a discussion of "fan fiction" and encouraging interested students to use their gaming world as the setting for a story. These stories fed off each other, as is demonstrated by this example from a student's comment on the site: "This is actually pretty cool. I don't like Terraria, but this is so good sounding how you incorporated it into a story. I might use this as inspiration for a Minecraft one." This student went on to write a story inspired by Minecraft, a game he preferred.

With the encouragement of librarians, several students relished the opportunity to write about their interests. Often they incorporated video games into their narrative, as noted above. As noted in the *Framework*, it is important that learning be connected to students' experiences. Sci-Dentity sessions that were co-designed by librarians further inspired students to make science connections to their "real lives."

Librarians are also knowledgeable about which products created by students would foster student engagement. For example, during the planning stages of Sci-Dentity, the librarians identified as a priority producing a final project in book form. They felt that, in addition to publishing online stories that required the inclusion of science facts, producing such stories to be included in a book would spur students to engage more deeply with inquiry and writing. The librarians also noted that students would be inspired by seeing the final stories of all Sci-Dentity students; as a result, the final book included a story by each student across all the schools, as opposed to a separate book for each site.

Framework Principle Three: Embrace Diversity as a Means to Enhance Learning Science.

The entire premise of Sci-Dentity and the collaborative approach—between researchers and librarians and among the students themselves—is built on the idea that learning is predicated on an open and respectful exchange of information and ideas across cultures and customs. This stance is reflected in numerous responsibilities and dispositions in the *Standards*. For the purposes of this section, we will focus on "Maintain openness to new ideas by considering divergent opinions, changing opinions or conclusions when evidence supports the change, and seeking information about new ideas encountered through academic or personal experiences" (disposition 4.2.3 in Appendix A).

While this thread ran through the entire program, some lessons in particular elicited discussion about diverse experiences and points of view. For example, as a result of brainstorming with the school librarians, one session was dedicated to the concept of utopia and dystopia. Students were asked to consider different conceptions of the future: the shiny optimism of the 1950s exemplified, for example, by the *Jetsons*, in contrast to the dystopian lens popular in young adult fiction today, such as in *The Hunger Games*. Each librarian facilitated a discussion of how students envisioned the future: a happy time with their favorite foods available at the touch of a button or a dark time in which humanity is imperiled. Also discussed were the cultural connotations associated with each view and the technology that created or is present in that future. In this way, students were asked to consider their peers' conceptions and experiences before undertaking their own writing processes. Each student incorporated his or her own unique background in the librarian-facilitated discussion of what a distant future might look like. Some students are recent immigrants; some are deeply involved in their church communities; some are well-traveled. The students even connected the discussion to the media with which they identify, such as *Book of Eli*, a post-apocalyptic action film with Denzel Washington as the African American lead actor. By asking the students to consider the role of technology in the future they imagine, librarians worked to spark thoughtful questions and imaginative ideas about the role science plays in shaping the future.

Framework Principle Four: Science Learning Is a Social Enterprise.

In Sci-Dentity, students conclude their inquiry-based research process by sharing their stories on Sci-Dentity's social-media site (skill 3.1.1 in Appendix A). The school librarians and researchers co-designed the features of the site to ensure participants of Sci-Dentity are able to communicate their science stories ethically on this site (skill 3.1.2 in Appendix A). Analysis revealed that the librarians impacted the design of the site to encourage students' engagement in the site and in sharing their stories. For example, the librarians and researchers worked to encourage students to respect the copyright of image creators, to cite sources, and to understand the ethics of using and sharing information. As a result, the researchers embedded information within the sessions about noting the source of images and suggesting use of intellectual property offered under a Creative Commons license.

Using information and technology ethically and responsibly is the pillar of any information-literacy instruction (skill 3.1.6 in Appendix A). One goal of Sci-Dentity is to teach ethical use of information. We found that the librarians in the program were already facilitating development of this skill through discussions of plagiarism, fair use, and copyright. Students experienced plagiarism and unfair use firsthand at the Sci-Dentity site. A feature allowed users to "clone" another student's story. While the original intent for this feature was to encourage students to remix their peers' work, because the cloning feature did not require changes to be made to the original, many students were able to clone their peers' stories without making any new additions

(angering the original authors in the process). The librarians and students brainstormed solutions, including a session on copying, plagiarism, remix, and attribution (Ahn et al. 2012), as well as changes to the site itself, including the option for students to disallow the cloning of their posts.

According to the *Framework*, it is imperative that science learning involves exchanges and discourse with a community of peers, and disposition 3.2.1: "Demonstrate leadership and confidence by presenting ideas to others in both formal and informal situations" and responsibility 1.3.4: "Contribute to the exchange of ideas within the learning community" (see Appendix A) capture this essence. Librarians in the program used their unique knowledge of their students to draw out participation in discussions and on the site while emphasizing the responsibility that comes with social interaction.

Because Sci-Dentity incorporates an online social-media platform, it is inherently social, but the participation of school librarians was crucial to encourage active participation. For example, Grant had the opportunity to draw students into deeper discussions and share their research; he also arranged for access to the site during the school day. Amy's close relationship with her students resulted in a deeper conversation about students' perspectives on appropriation and remixing. Nancy frequently encouraged her students to share with the entire group science facts that they were using in their stories, and sought suggestions of other science facts and resources that were relevant. Numerous roles are at play in these examples of the librarians' work in the Sci-Dentity program, and each of the roles enhances the science-learning process for students.

Conclusion and Further Research

The research team, consisting of school-library researchers and learning-scientists, was aware of the mandated roles that school librarians play in schools and their abilities to impart and develop in young people the skills, dispositions, and responsibilities in the *Standards*. Although most research in school librarianship demonstrates the ability of school library programs to impact higher achievement in reading and writing among young people (Francis and Lance 2011; Lance and Russell 2004; Library Research Service 2011), we believe that librarians can function in these mandated roles in science learning as well. In Sci-Dentity we discovered that librarians' roles and areas of expertise can be extended to assist in science learning, especially in aiding the creation of a sociocultural environment that is conducive for science exploration. Through their involvement with Sci-Dentity, these school librarians played the roles of information specialist, instructional partner, teacher, program administrator, and leader in science learning at varying intensities and success levels. Using Sci-Dentity as the context for implementation of a science-learning program, we were able to illuminate some examples of how school librarians can play and extend their five mandated roles in schools.

As we developed the crosswalk between the *Framework* and the *Standards* (Appendix B), we saw clear links between (a) skills, dispositions, and responsibilities articulated in the *Standards* and imparted in Sci-Dentity and (b) science-learning principles in the *Framework*. As indicated in Appendix B, multiple skills, dispositions, and responsibilities in the *Standards* align with the four principles of science learning that are highlighted in this paper; this circumstance emphasizes the need for students to possess information-literacy, technology, media, and inquiry skills and dispositions to be able to participate and be successful in science-learning environments.

From our analysis described earlier, we found that school librarians are strong assets in science learning as they are able to encourage young people to engage in authentic inquiry practices,

engage learners' everyday-life interests, incorporate into science discussions the diversity of students' perspectives, and facilitate following the norms of scientific discourse.

We also view this study as an opportunity for reflection and an impetus for further brainstorming with the librarians on how, through Sci-Dentity, we can facilitate the learning of all the AASL skills, dispositions, and responsibilities listed in the crosswalk in Appendix B. The roles that individual librarians played in facilitating development of each of these skills, dispositions, and responsibilities varied greatly; some librarians needed more support in facilitating one element than another element.

We understand that Sci-Dentity cannot be implemented in every school, but librarians in K–12 schools can begin adapting and adopting similar approaches to formal science learning in schools. We hope to further this exploration by making more connections to the actual school curriculum and demonstrating stronger involvement of school library programs in formal science learning. Differences in school librarians' backgrounds, post-graduate training, experiences, and interests may have an impact in their abilities to function in creating and sustaining sociocultural science-learning environments in their schools. Involvement in formal science learning faces further challenges such as resource allocations, institutional structures, scheduling, time investment, division of labor, and many more aspects of the school systems that will need to be explored and studied in the future.

In this era of budget cuts and reduced resource allocation, school librarians are faced with a challenge to demonstrate the impact of their programs on young people's achievements (ALA 2012; Blankinship 2011). Because STEM is more than a buzzword in the current American educational system, we believe that demonstrating the link between science and school libraries will be beneficial in sustaining strong library programs in schools. The focus on science learning is shifting from the memorization of facts to application of new knowledge by leveraging sociocultural aspects surrounding students' interests and environments. Such a shift in the current approach to science learning paves the way for librarians to make an entry into science learning.

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Appendix A: *Standards for the 21st-Century Learner*

This appendix contains the text of the standards portion of the *Standards for the 21st-Century Learner* document. A free PDF file of the complete *Standards* document, including the common beliefs, can be downloaded from <www.ala.org/aasl/standards-guidelines/learning-standards>. For guidance on implementing the standards and for benchmarks for grades 2, 5, 8, 10, and 12, see *Standards for the 21st-Century Learner in Action*, a book that is available for purchase at the AASL website.

Standard One—Inquire, think critically, and gain knowledge.

1.1 Skills

1.1.1 Follow an inquiry-based process in seeking knowledge in curricular subjects, and make the real-world connection for using this process in own life.

1.1.2 Use prior and background knowledge as context for new learning.

1.1.3 Develop and refine a range of questions to frame the search for new understanding.

1.1.4 Find, evaluate, and select appropriate sources to answer questions.

1.1.5 Evaluate information found in selected sources on the basis of accuracy, validity, appropriateness for needs, importance, and social and cultural context.

1.1.6 Read, view, and listen for information presented in any format (e.g., textual, visual, media, digital) in order to make inferences and gather meaning.

1.1.7 Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, and point of view or bias.

1.1.8 Demonstrate mastery of technology tools for accessing information and pursuing inquiry.

1.1.9 Collaborate with others to broaden and deepen understanding.

1.2 Dispositions in Action

1.2.1 Display initiative and engagement by posing questions and investigating the answers beyond the collection of superficial facts.

1.2.2 Demonstrate confidence and self-direction by making independent choices in the selection of resources and information.

1.2.3 Demonstrate creativity by using multiple resources and formats.

1.2.4 Maintain a critical stance by questioning the validity and accuracy of all information.

1.2.5 Demonstrate adaptability by changing the inquiry focus, questions, resources, or strategies when necessary to achieve success.

1.2.6 Display emotional resilience by persisting in information searching despite challenges.

1.2.7 Display persistence by continuing to pursue information to gain a broad perspective.

1.3 Responsibilities

1.3.1 Respect copyright/intellectual property rights of creators and producers.

1.3.2 Seek divergent perspectives during information gathering and assessment.

1.3.3 Follow ethical and legal guidelines in gathering and using information.

1.3.4 Contribute to the exchange of ideas within the learning community.

1.3.5 Use information technology responsibly.

1.4 Self-Assessment Strategies

1.4.1 Monitor own information-seeking processes for effectiveness and progress, and adapt as necessary.

1.4.2 Use interaction with and feedback from teachers and peers to guide own inquiry process.

1.4.3 Monitor gathered information, and assess for gaps or weaknesses.

1.4.4 Seek appropriate help when it is needed.

Standard Two—Draw conclusions, make informed decisions, apply knowledge to new situations, and create new knowledge.

2.1 Skills

2.1.1 Continue an inquiry-based research process by applying critical-thinking skills (analysis, synthesis, evaluation, organization) to information and knowledge in order to construct new understandings, draw conclusions, and create new knowledge.

2.1.2 Organize knowledge so that it is useful.

2.1.3 Use strategies to draw conclusions from information and apply knowledge to curricular areas, real-world situations, and further investigations.

2.1.4 Use technology and other information tools to analyze and organize information.

2.1.5 Collaborate with others to exchange ideas, develop new understandings, make decisions, and solve problems.

2.1.6 Use the writing process, media and visual literacy, and technology skills to create products that express new understandings.

2.2 Dispositions in Action

2.2.1 Demonstrate flexibility in the use of resources by adapting information strategies to each specific resource and by seeking additional resources when clear conclusions cannot be drawn.

2.2.2 Use both divergent and convergent thinking to formulate alternative conclusions and test them against the evidence.

2.2.3 Employ a critical stance in drawing conclusions by demonstrating that the pattern of evidence leads to a decision or conclusion.

2.2.4 Demonstrate personal productivity by completing products to express learning.

2.3 Responsibilities

2.3.1 Connect understanding to the real world.

2.3.2 Consider diverse and global perspectives in drawing conclusions.

2.3.3 Use valid information and reasoned conclusions to make ethical decisions.

2.4 Self-Assessment Strategies

2.4.1 Determine how to act on information (accept, reject, modify).

2.4.2 Reflect on systematic process, and assess for completeness of investigation.

2.4.3 Recognize new knowledge and understanding.

2.4.4 Develop directions for future investigations.

Standard Three—Share knowledge and participate ethically and productively as members of our democratic society.

3.1 Skills

3.1.1 Conclude an inquiry-based research process by sharing new understandings and reflecting on the learning.

3.1.2 Participate and collaborate as members of a social and intellectual network of learners.

3.1.3 Use writing and speaking skills to communicate new understandings effectively.

3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.1.5 Connect learning to community issues.

3.1.6 Use information and technology ethically and responsibly.

3.2 Dispositions in Action

3.2.1 Demonstrate leadership and confidence by presenting ideas to others in both formal and informal situations.

3.2.2 Show social responsibility by participating actively with others in learning situations and by contributing questions and ideas during group discussions.

3.2.3 Demonstrate teamwork by working productively with others.

3.3 Responsibilities

3.3.1 Solicit and respect diverse perspectives while searching for information, collaborating with others, and participating as a member of the community.

3.3.2 Respect the differing interests and experiences of others, and seek a variety of viewpoints.

3.3.3 Use knowledge and information skills and dispositions to engage in public conversation and debate around issues of common concern.

3.3.4 Create products that apply to authentic, real-world contexts.

3.3.5 Contribute to the exchange of ideas within and beyond the learning community.

3.3.6 Use information and knowledge in the service of democratic values.

3.3.7 Respect the principles of intellectual freedom.

3.4 Self-Assessment Strategies

3.4.1 Assess the processes by which learning was achieved in order to revise strategies and learn more effectively in the future.

3.4.2 Assess the quality and effectiveness of the learning product.

3.4.3 Assess own ability to work with others in a group setting by evaluating varied roles, leadership, and demonstrations of respect for other viewpoints.

Standard Four—Pursue personal and aesthetic growth.

4.1 Skills

4.1.1 Read, view, and listen for pleasure and personal growth.

4.1.2 Read widely and fluently to make connections with self, the world, and previous reading.

4.1.3 Respond to literature and creative expressions of ideas in various formats and genres.

4.1.4 Seek information for personal learning in a variety of formats and genres.

4.1.5 Connect ideas to own interests and previous knowledge and experience.

4.1.6 Organize personal knowledge in a way that can be called upon easily.

4.1.7 Use social networks and information tools to gather and share information.

4.1.8 Use creative and artistic formats to express personal learning.

4.2 Dispositions in Action

4.2.1 Display curiosity by pursuing interests through multiple resources.

4.2.2 Demonstrate motivation by seeking information to answer personal questions and interests, trying a variety of formats and genres, and displaying a willingness to go beyond academic requirements.

4.2.3 Maintain openness to new ideas by considering divergent opinions, changing opinions or conclusions when evidence supports the change, and seeking information about new ideas encountered through academic or personal experiences.

4.2.4 Show an appreciation for literature by electing to read for pleasure and expressing an interest in various literary genres.

4.3 Responsibilities

4.3.1 Participate in the social exchange of ideas, both electronically and in person.

4.3.2 Recognize that resources are created for a variety of purposes.

4.3.3 Seek opportunities for pursuing personal and aesthetic growth.

4.3.4 Practice safe and ethical behaviors in personal electronic communication and interaction.

4.4 Self-Assessment Strategies

4.4.1 Identify own areas of interest.

4.4.2 Recognize the limits of own personal knowledge.

4.4.3 Recognize how to focus efforts in personal learning.

4.4.4 Interpret new information based on cultural and social context.

4.4.5 Develop personal criteria for gauging how effectively own ideas are expressed.

4.4.6 Evaluate own ability to select resources that are engaging and appropriate for personal interests and needs.

Appendix B: Crosswalk between *Framework* and *Standards*

***Framework* Principle One: Children are born investigators.**						
AASL Skills	***Standard One***	1.1.1 Follow an inquiry-based process in seeking knowledge in curricular subjects, and make the real-world connection for using this process in own life.	1.1.3 Develop and refine a range of questions to frame the search for new understanding.	1.1.7 Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, and point of view or bias.		
	Standard Two	2.1.1 Continue an inquiry-based research process by applying critical-thinking skills (analysis, synthesis, evaluation, organization) to information and knowledge in order to construct new understandings, draw conclusions, and create new knowledge.				
	Standard Three	3.1.1 Conclude an inquiry-based research process by sharing new understandings and reflecting on the learning.				
	Standard Four	4.1.4 Seek information for personal learning in a variety of formats and genres.	4.1.5 Connect ideas to own interests and previous knowledge and experience.			
AASL Dispositions in Action	***Standard One***	1.2.1 Display initiative and engagement by posing questions and investigating the answers beyond the collection of superficial facts.	1.2.4 Maintain a critical stance by questioning the validity and accuracy of all information.	1.2.5 Demonstrate adaptability by changing the inquiry focus, questions, resources, or strategies when necessary to achieve success.	1.2.6 Display emotional resilience by persisting in information searching despite challenges.	1.2.7 Display persistence by continuing to pursue information to gain a broad perspective.
	Standard Two	2.2.2 Use both divergent and convergent thinking to formulate alternative conclusions and test them against the evidence.				
	Standard Four	4.2.2 Demonstrate motivation by seeking information to answer personal questions and interests, trying a variety of formats and genres, and displaying a willingness to go beyond academic requirements.				
AASL Responsibilities	***Standard One***	1.3.2 Seek divergent perspectives during information gathering and assessment.				
	Standard Two	2.3.3 Use valid information and reasoned conclusions to make ethical decisions.				

	Standard Three	3.3.1 Solicit and respect diverse perspectives while searching for information, collaborating with others, and participating as a member of the community.	3.3.2 Respect the differing interests and experiences of others, and seek a variety of viewpoints.

***Framework* Principle Two: Learning must connect to students' interests and experiences.**					
AASL Skills	***Standard One***	1.1.1 Follow an inquiry-based process in seeking knowledge in curricular subjects, and make the real-world connection for using this process in own life.		1.1.2 Use prior and background knowledge as context for new learning.	
	Standard Two	2.1.3 Use strategies to draw conclusions from information and apply knowledge to curricular areas, real-world situations, and further investigations.			
	Standard Three	3.1.5 Connect learning to community issues.			
	Standard Four	4.1.1 Read, view, and listen for pleasure and personal growth.	4.1.2 Read widely and fluently to make connections with self, the world, and previous reading.	4.1.4 Seek information for personal learning in a variety of formats and genres.	4.1.5 Connect ideas to own interests and previous knowledge and experience.
AASL Dispositions in Action	***Standard Four***	4.2.2 Demonstrate motivation by seeking information to answer personal questions and interests, trying a variety of formats and genres, and displaying a willingness to go beyond academic requirements.		4.2.4 Show an appreciation for literature by electing to read for pleasure and expressing an interest in various literary genres.	
AASL Responsibilities	***Standard Two***	2.3.1 Connect understanding to the real world.			
	Standard Three	3.3.4 Create products that apply to authentic, real-world contexts.			
	Standard Four	4.3.3 Seek opportunities for pursuing personal and aesthetic growth.			

***Framework* Principle Three: Embrace diversity as a means to enhance learning science.**			
AASL Skills	***Standard One***	1.1.7 Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, and point of view or bias.	
AASL Dispositions in Action	***Standard Four***	4.2.3 Maintain openness to new ideas by considering divergent opinions, changing opinions or conclusions when evidence supports the change, and seeking information about new ideas encountered through academic or personal experiences.	
AASL Responsibilities	***Standard One***	1.3.2 Seek divergent perspectives during information gathering and assessment.	
	Standard Two	2.3.2 Consider diverse and global perspectives in drawing conclusions.	
	Standard Three	3.3.1 Solicit and respect diverse perspectives while searching for information, collaborating with others, and participating as a member of the community.	3.3.2 Respect the differing interests and experiences of others, and seek a variety of viewpoints.

***Framework* Principle Four: Science learning is a social enterprise.**				
AASL Skills	***Standard One***	1.1.9 Collaborate with others to broaden and deepen understanding.		
	Standard Two	2.1.5 Collaborate with others to exchange ideas, develop new understandings, make decisions, and solve problems.		
	Standard Three	3.1.2 Participate and collaborate as members of a social and intellectual network of learners.	3.1.6 Use information and technology ethically and responsibly.	
	Standard Four	4.1.7 Use social networks and information tools to gather and share information.		
AASL Dispositions	***Standard Three***	3.2.1 Demonstrate leadership and confidence by presenting ideas to others in both formal and informal situations.	3.2.2 Show social responsibility by participating actively with others in learning situations and by contributing questions and ideas during group discussions.	3.2.3 Demonstrate teamwork by working productively with others.

AASL Responsibilities	***Standard One***	1.3.4 Contribute to the exchange of ideas within the learning community.		
	Standard Three	3.3.1 Solicit and respect diverse perspectives while searching for information, collaborating with others, and participating as a member of the community.	3.3.3 Use knowledge and information skills and dispositions to engage in public conversation and debate around issues of common concern.	3.3.5 Contribute to the exchange of ideas within and beyond the learning community.
	Standard Four	4.3.1 Participate in the social exchange of ideas, both electronically and in person.		

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