The Youth Engagement with Science and Technology Survey:

Informing Practice and Measuring Outcomes

Paper to be Presented at NARST (National Association for Research on Science Teaching)

2010 Annual Meeting, Philadelphia, PA

By Glenda McCarty (glendamccarty@gmail.com),

Jennifer Hope (jmghope@gmail.com),

and

Joseph L. Polman (polman@umsl.edu)

University of Missouri-St. Louis

Abstract

Engagement in science and technology is plainly relevant to the development and an important outcome of informal and formal education, but the term “engagement” has had many meanings. In this paper, the authors review uses of the term, and propose a framework for engagement including behavior, interest, and identity. The development process for a survey instrument to measure engagement based on this framework is described. The Youth Engagement in Science and Technology (YEST) Survey will be a more valid measure than is currently available, allowing researchers to study more closely how individuals with different engagement profiles learn, and also measure the impacts of in-school and out-of-school programs on engagement. The YEST survey is being developed and piloted within the context of a larger science education reform project engaging high school students in science journalism. The development process and preliminary results of the pilot administration will be presented, and issues with the survey's meaning and validity examined through case studies of youth engagement. The potential relationship to practice will be discussed.

The Youth Engagement with Science and Technology Survey: Informing Practice and Measuring Outcomes

Many recent studies of science education interventions focus mainly on "engagement" as indicated by student achievement in the science classroom (Lichtenstein et. al, 2008; Markowitz, 2004; Martin, 2005). Such research considers engagement in academic terms—as a measure of time spent on tasks in the classroom (Lee & Anderson, 1993) and/or at home, such as planning, homework, and studying (Singh, Granville, & Dika, 2002). Additional variables studied in relation to student achievement in science include interest and perceived ability (Markowitz, 2004), motivation (Thompson & Windschitl, 2002), and interaction rituals and learning environment (Olitsky, 2007).

Fewer studies of organized education programs consider science engagement related to students' personal lives. While still focused on the outcome of academic achievement, Lau and Roeser (2002) posed that engagement involves multiple facets, including positive feelings and focused attention during the learning activity as well as amount of time spent on school assignments or other science-related tasks during non-school hours. Barton and colleagues (Basu & Barton, 2007; Furman and Barton, 2006) studied urban minority youth in after-school programs, finding that connecting science experiences with students' own future plans, in a social learning environment that supported student agency, led to what they considered a sustained interest in science, and to shifts in identity. Ethnographic research from the Learning in Informal and Formal Environments Center (e.g., Barron, 2006; Zimmerman & Bell, 2007), has shown the myriad ways that youth engage with science and technology activities in the out of school hours, including personally meaningful experiences at home that school people seldom know about. These results align with Azevedo's (2004) finding that individuals' goals, interests, values and beliefs result in preferences which interact with sociocultural milieus to foster "persistent engagement in a practice."

Other studies from the literature on out-of-school, museum, and informal learning have shown ways that people engage with science and technology in the public realm. Research in museums, national parks, and science centers (Falk, et al., 2001; Durant, 1999) shows the public does engage with science and technology, but the public's engagement with free-choice science learning is poorly understood (Falk, et.al, 2007) and has not been fully researched (Falk, et.al, 2007; Korpan, et.al, 1997). Research suggests that the science the public engages with and knows is not exclusively learned in school—the public perceives other sources to be of equal importance when seeking information and knowledge about science and technology (Falk, et.al, 2007; Durant, 1999). Science learning is driven by the public's needs and interests (Korpan, et.al, 1997). Data gathered about books being read, television programs watched, games played, and Internet searching, could lead to insights of how people learn science and influence practices in schools (Korpan, et.al, 1997). Citizens may engage deeply

with public policy debates involving science and technology (Miller, 1992, 1998), and recent working groups have stressed the importance of two-way communication and mutual learning between publics and scientists or policy makers (McCallie et al., 2009).

The authors of this paper are part of the Science Literacy through Science Journalism (SciJourn; http://www.scijourn.org; Polman, Saul, Newman, and Farrar, 2008; Polman, et al., 2010) research grant aimed at increasing science literacy by involving youth in schools and community programs in science journalism. We have been influenced by the above work, but also believe that the Science, Technology, Engineering and Mathematics (STEM) fields would be well served by following a similar path to that blazed by Roy Rosenzweig and David Thelen in the discipline of history. Public debates on history education (as with science education), have often focused on outrage over what facts students do not know, and lament how little interest students show in learning history in school. In the late 1990s, Rosenzweig and Thelen reframed the discussion of how educated citizens *understood* history by conducting research on how citizens in the United States were actually *engaged with* the past. Their survey of a broad set of Americans, described in *The Presence of the Past* (1998), revealed that many Americans were deeply engaged with the past in their leisure time, and concluded that this engagement with the past could be an entry into developing greater understanding through public programs and educational efforts. We see a similar path for science engagement as aligned with recent reframings of science literacy as "public understanding of and engagement with science and technology."

In this paper, we articulate our own view of engagement with science and technology in an attempt to clarify this idea. We then describe our efforts to develop the Youth Engagement in Science and Technology (YEST) Survey. We expect this clarification of "engagement" and the accompanying survey to be useful in two ways: to enhance our understanding of the ways that youth are presently engaged in science and technology in school and out, and as a valid means to measure changes over time in engagement as an indicator of educational outcomes.

In our view, including academic understanding issues under the rubric of engagement is not helpful, since we and others are willing to address understanding separately. We believe that a coherent concept of engagement, which captures what is meaningful about the term as it is generally used, includes three facets:

- **Behavior**, or actual involvement with science and technology ideas and tools
- **Interest**, or openness to and stance toward the science and technology in the moment
- **Identity**, or ways that the science and technology connects to people's identity affiliations, in the past, present, and future

In the following section, we describe our efforts to operationalize these facets in a small research study that will result in a written survey intended for broader use.

Method

Our development project for this engagement survey is embedded in the multi-year SciJourn research project aimed at increasing public understanding and engagement with science and technology by involving youth from schools and an out-of-school apprenticeship program in science journalism (see next paragraph for a brief overview). In 2008-2009, we conducted a literature review and developed the initial version of the survey, which we tested and refined with a small group of teens in a youth development program at an informal science institution in a large Midwestern city. During the 2009-2010 school year, we are piloting the survey with a larger pool of 13 teachers and their students at 10 schools in the greater Metropolitan region of the same Midwestern city. The methods of our development follow the recommendations of Fowler (2009) on survey development: we developed the survey based on previous surveys and the literature, utilized interviews and verbal think-aloud protocols to refine the survey instrument, and are administering the pilot survey to a broad audience, after which we will analyze the results.

As mentioned above, the survey development and the case studies described in this paper are part of the larger SciJourn research and development project. The teens who provided the initial survey feedback and the case studies were involved in an established youth development and employment program run out of a local informal science institution. More details on identity development and apprenticeship learning in this program is available elsewhere (see Polman & Miller, 2008, in press), but an overview of the program will be helpful. The youth participants were all high school aged participants, recruited into the overall program initially from community partner organizations, who had applied to be part of the SciJourn program in the summer of 2009. The overall youth program that summer included numerous subgroups, and over 150 teens. During the five weeks of that summer program, the four female and three male SciJourn participants worked for approximately five hours a day for five days a week in the program. During this time, they learned about science journalism, and were the reporters for the first three editions of *The SciJourner*, a print newspaper produced by the project. Overall, this youth program enjoys a relatively high adult-teen ratio, and this SciJourn group of teens had even more support: there were two adult supervisors employed full-time by the informal science institution, one of whom had been with the program for several years, and one of whom had a writing background; in addition, they were supported by a college-aged intern supervisor, who was studying to become a teacher, and a grant Co-PI (Alan Newman) with a background as the editor of a professional science news publication (who served as managing editor of *The SciJourner*). During the course of the summer, the teens developed story ideas that they "pitched" to one another and their supervisors in what the group referred to as a "fishbowl", conducted research and original reporting on their stories, wrote drafts and submitted them electronically, received

feedback using Microsoft Word's "Track Changes" feature, and revised their articles. As was standing practice in the youth development program, they also performed public service "teaching" activities, in this case assisting senior citizens at a nearby facility in learning to search for useful and credible information on the Internet.

From other survey instruments (Rosenzweig & Thelen, 1998; Preczewski, et.al, 2009; Falk, et.al, 2001) and prior work (Polman & Miller, 2008, in press), the research group first developed a survey questionnaire to be used verbally, within an interview style format, with this group of eight teens involved in the project's summer program. The goal of the first interview was to document by means of audio recording and field notes the verbal responses to the questions and to note potential problems and issues within the instrument (Fowler, 2009). This initial interview served as a foundation for developing a revised instrument, which mirrored the survey that would eventually be used with a broader group of individuals. During the second round of interviews with the same group of teens, the researchers instructed the teens to fill out the questionnaire and encouraged them to verbalize any thoughts, questions, and concerns regarding the survey, while the interviewer asked probing questions to facilitate a discussion around the survey. The researchers discussed the issues and concerns of the second interview and survey instrument in order to make necessary changes and adjustments to finalize the written survey instrument, which were used within the broader pilot study at schools during 2009-2010, which is to be followed by a full implementation of intervention and comparison groups in 2010-2011.

Seven of the eight teens who participated in the summer 2009 survey development procedures described above were the subjects of observational case study research on engagement, which contextualize survey findings and provide additional insights for survey refinement. We present four representative teen case studies here, which are based on interviews of students regarding survey and program, observational field notes of program participation and engagement, and preliminary survey think-alouds and group discussion. Several hundred students of 13 teachers from ten high schools participating in the wider research project were administered the current YEST Survey in the 2009-2010 school year, pre-intervention (complete but not yet analyzed) and post-intervention (to be administered in May). The input of the teachers was taken into account for a revision of the survey as well.

Analyses and Findings

The nascent survey itself is one result of the project, which has been revised to its current state (see Appendix) based on initial interview administration and individual written administration with think-alouds of the eight participants, as well as a focus group discussion of the measure with the entire group of eight. Additional feedback from teachers and project partners who administered the survey during the school year has

also been incorporated into the present version. The first two phases of review have resulted in the separation of science from technology questions, the separation of websites from other media sources, and in the creation of categories for closed-ended responses (e.g., common reasons for participating in activities).

The survey is organized into five sections: demographics/background , science behaviors, technology behaviors, interest in science and technology, and future. Our rationale for the design and inclusion of these questions, and the role they play in assessing engagement as a product of student behavior, interest, and identity, follows.

Demographics

Demographic information is typically collected from survey participants in order to allow incorporation of common variables in the analysis. In addition, this information allows researchers to become familiar with the make-up of the participant group. The initial questions of the YEST survey provides a description of the distribution of gender (five female; three male), ethnicity (seven African American; one European American), first language (seven English, one Albanian), grade level (two sophomores, three juniors, and three seniors), geographic distribution (seven different metropolitan zip codes), and type of school attended (six public, one private parochial) for the participant group. The last question in the demographics section asks youth to list the main ways in which they spend their free time. The group reported spending their time on fairly typical teenage activities: listening/playing/dancing to music (5), hanging out with friends (2), reading (2), studying (2), watching TV/movies (2), eating, sleeping, driving, playing sports, school activities, skateboarding, and helping family. This final question provides an initial glimpse into individual youth behavior, interest, and identity—the three main components of our definition of science engagement. The rest of the survey is designed to gather data to elaborate upon each of these aspects.

Behavior

The "Science and Technology Activities" section of the survey asks respondents to rate the importance of science to their individual lives. Six of our seven participants rated science to be "very important", and one rated it "somewhat important." Ways in which youth reported experiencing science in their everyday lives reflected this group's school and work (at the informal science institution) activities (4 youth), as well as recognition of the science involved in other, more typical daily situations, such as skating; cooking, cleaning, and bathing; and "the activities [that] would involve using my body (like clothing myself and getting ready for work)." All eight youth rated technology as "very important" to their everyday lives. One listed "writing, reading, walking, riding the bus, [and] typing articles" as her everyday activities involving technology. Classwork, personal activities (2), and work were also reported, along with a wide variety of technological tools, such as cell phones (4), computer (3), the Internet (2) television (2), transportation (2), dishwasher, and

alarm clock.

The rest of this section inquires into the enacted behaviors of youth related to science and technology, asking them to report the frequency with which they 1.) Utilize different sources (teacher, family member, textbook, other books, magazines, TV/movies, internet, or radio) when seeking out topical information, and 2.) Engage with science and technology through different activities such as reading books or magazines, watching TV shows or movies, visiting websites, participating in organized groups, visiting sites (like museums), or other activities related to either science or technology. Follow-up questions ask youth to specify any or all of the reasons they participate in chosen activities, whether for a school or work requirement, personal enjoyment or learning, decision-making, or interest related to a future educational or career goal. In order to shorten the survey, items asking students to specify the actual books, magazines, TV shows, movies, and other activities in which they engaged in their free time were eliminated.

Sources of information.

All seven youth in the SciJourn group reported "always" using the Internet as a resource for science and technology information. Four of the students also "always" refer to a teacher for information on science; three gave the same response on technology, but two also stated they would "never" refer to the teacher for technological information. Family members and magazines were reported as the least frequent sources of science information, while family members, textbooks, and other books were reported as the least frequently sourced for technology information.

Activities.

The most common science and technology activities these teens engaged in were by far watching related TV/movies and visiting related websites. The least frequent activities were participation in clubs or groups related to science and technology, although two of the youth are involved in such activities (beyond their participation in the youth development program).

Interest

The YEST survey asks youth to rate their interest in 1.) school (general), 2.) learning about science in school, 3.) learning about science outside of school, 4.) learning about technology in school, and 5.) learning about technology out of school, on a five-point scale (one low, five high). Figure 1 illustrates the average of the seven individuals' responses to these items. The greatest overall interest was expressed in learning about technology in school (mean of 4.18). The group average interest in school was 3.64, the same as interest in learning about science out of school, but the range of responses varied more with regard to learning about science and technology in and out school. Five youth indicated that they are interested in school some of the time, whereas five students rated their interests in science (in and out of school) and technology (out of school)

a four (most of the time) or five (my favorite subject). Specific interests in science and technology are varied, and include chemistry (3), astronomy (2), biology, computers, engineering, and medicine. One youth described his interests more specifically, listing "robotics, nano-technology, brain-computer interfaces, etc." while another stated more generally that "just the whole thing about technology interests me."

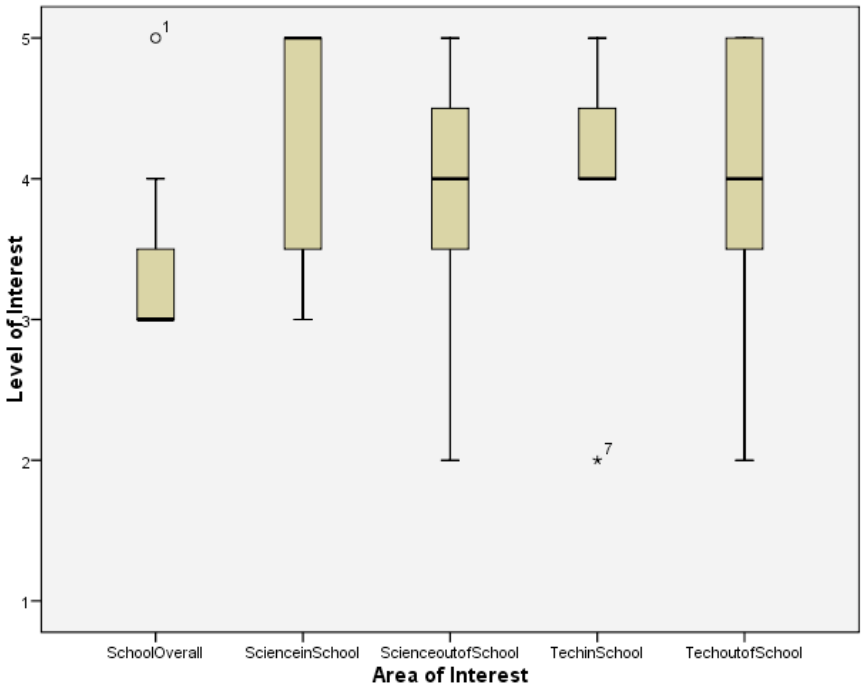

Figure 1. Levels of Student Interest

Identity

While identity is certainly related to some interplay of interest and behavior, some specific questions were included in the survey to add to those components in an effort to form a clearer picture of each individual's identity. Youth were asked to evaluate themselves as learners as well as their performance in school as assessed by grades, both on a five-point scale. The SciJourn group is made up of three individuals who consider themselves "average" students, two "good", and two "excellent," in terms of grades (mean=3.91). This group considers themselves better learners than most of their peers; three participants scored themselves "good" learners, two "excellent," and two "average" (mean=4.36). On a scale of one to ten, these seven score themselves an average of 9.22, when comparing their own knowledge of science and technology to that of an average high school student. Given these particular teens' involvement in a year-round, multi-year science and technology program outside of school, these fairly high scores are as expected, and we consider these results valuable in confirming the validity of self-reporting by teenagers.

Despite this particular interest and involvement in science, only two of the seven responded positively to the notion of seeing themselves as scientists. One of these elaborated that such identity would be claimed "when I'm in [my] 40's at a university," and the other didn't respond to the follow-up question as to when and where she sees herself as a scientist. Two commented that further education and or work experience would be required before viewing themselves in this manner. Two further questions about science expertise, "What does it take to be good at science?" and "What should a person know about science?" were omitted due to apparent confusion amongst the respondents in answering. In their place, the question, "What can someone who is good at science do?" was added to the current version.

The final section of the survey, consisting of nine questions, aims to gain insight into student identity by considering students' future plans, and the ways in which they believe science and technology will play a part in their foreseen educational, professional, and personal lives. The SciJourn group sees themselves as college-bound future professionals, in prestigious career fields such as medicine, law, engineering, and information technology. Two of them mention plans for international study or work within the next ten years. Overall, this group views science (3.71 out of 4) and technology (3.83 out of 4) as "very important" to their educational and professional futures. (The current YEST survey asks participants to rate the level of importance of science and technology to their future personal lives, as well.) The ways in which science will be important listed by students are divergent. One, who plans to work in medicine, stated that "Science will be of importance, because it will be my career and I will try to find the answers to questions that go unsolved." Another also mentioned new discoveries in medicine. One believed "knowing and using critical thinking" will be important in her future as a lawyer. Other, vaguer, responses included "everything", "very important," and "religious persuasions, college studies, etc." Applications for technology in these students' future are somewhat more concrete. For example, our future doctor anticipated technology as the key to healing patients, the law-school bound student foresaw technology affecting the future courtroom, and three others envisioned using computers every day in their futures in IT and engineering. One student believed he would use technology as his "source of income and a way to put a dent in the universe" after completing his studies at MIT. And again, one simply stated that technology is important for "everything."

Case: Max

Max (all participant names are pseudonyms, with the exception of Co-PI Newman) is a high school senior at a suburban public school. He is a first generation immigrant from Eastern Europe. He has participated in this youth development program for three years, while maintaining other part-time employment. Max notes "hanging out with friends, on [sic] computer, and playing guitar" as the three main ways he spends his free

time. He is a self proclaimed "fun" guy, noted by his commonly answered YEST science and technology questions being "fun or personal enjoyment and/or wanted to learn more about the topic." He rates himself as an excellent learner with average grades, with science and technology being his favorite subjects. He notes that he will need to use computers every day of his life.

In the beginning of the summer program, Max distanced himself from the group by sitting slightly in the corner, seeming to not be a part of the group of teens. Over time, he began to build relationships with the other teens, but even moreso with the adults. He frequently had conversations with the editor of the newspaper and another adult researcher. Max, considering himself a techie, voiced his connection with one of the adult researchers by stating “I appreciate how you’re weird, and I know you’ll take that in a good way. And you’re a tech guy like me, which makes me more comfortable because there’s no one else here who likes tech as much as me.”

Max identified himself as, "bad at writing," and "bad at writing in English," yet, during the five week summer program, he produced three original stories, the most of any teen participant. All of Max's articles focused upon his high interest levels with science and technology, which were reflected on his YEST survey replies. His first story was on the SciJourn grant, his second on electric cars, and his third on the health risks of tattoos. This last story grew out of Max's own interest in tattoos; and also in the phenomenon of nonprofessionals giving themselves tattoos, which he himself had done. This quickly became a hot topic among the teens, their leaders, and the researchers.

> Tammy [adult supervisor]: Tattoos? There’s a lot of kids that have tattoos now.
> Ben [college-aged supervisor intern]: Max has a tattoo now.
> Max: [shows his ankle to Tammy].
> Ben: he did it himself.
> Jennifer [researcher]: [gets up to look at it] I’m impressed. But that’s not cool.
> Khadijah: That is cool, but I would never do it to myself.

Max's interest led to the pitch of a story on tattoos and the possible risks of getting one. He pitched the story to the group, with Alisha serving as the acting editor:

> Max: So, I’m gonna do a story about people spreading infections through tattoos and the risk of having one and not having one.
> Alisha: Yeah, I don’t have a tattoo, but is this article going to tell them they should get one or not.
> Max: No, it will address the facts
> Ben [college-aged supervisor intern]: Do you think you could find out from the YES teens how many tattoos they have?
> Max: Yes. Who in here has a tattoo?
> Alisha: I don’t know, give me something else? I’m not interested in tattoos, what about the infections?
> Max: People believe they can get HIV or herpes.
> Ben: How are you going to give straight facts, interest teens,

> Jaylen: There is a tattoo shop that gives them to teens [describes the location of shop and examples of people he knows that have gotten tattoos there.] My point is, don't you have to be 18 or something? My mom has not signed off on those.
> [Max starting to show his tattoo]
> Khadijah: Max, we don't want to see your tattoo. Tuck your shirt in.
> [Group discussing age, people giving their own tattoos, going to real tattoo parlors]
> Evelyn [adult supervisor]: Is the tattoo business regulated?
> Max: Yes, there are regulations. You cannot reuse the same needle unless you have an autoclave.
> Newman [adult supervisor]: How many people know someone that has a home tattoo?
> [almost all raise hands]
> Newman: See, they don't know the risks.
> Alisha: [discusses that she does not like tattoos] Go ahead. I would read it
> Tammy: You think teens [in the program] would be interested in this?
> Newman: How are you going to do [that]?
> Max: I can go around and ask questions.
> Ben: You can also go around to tattoo parlors and interview.
> [group likes it and discusses the teens would be interested in reading and seeing the possible risks of getting tattoos]

Max, along with Tiarra and Ben, visited a local tattoo parlor so they could do first-hand reporting on the risks of getting tattoos. In a follow-up interview with Max, he stated that the article on tattoos

> … was personal, since I had to go interview someone by myself and Alan's requirement was [to] make it original, trying to put as much science into it, in-house science. I had the interview myself. The picture was taken by Tiarra. So it was basically a straightforward original article that I guess you can't find on the Internet really. I mean, similar articles, but I made this one.

In Max's case, the results of the YEST survey did seem to illustrate his proclaimed interests in science and technology. While aligning with his interests, he was able to produce three science articles while showing much ownership over the final product. In conversations pertaining to his article in print, Max even became engaged with the details of writing and layout; he made the following statements: "You didn't do the thing about wrapping the text, either ...Alignment to the right. Image description. Okay. What did you say about the title?" In alignment with the YEST answers, Max was able to have fun and capitalize on his interests with science and technology while developing his competency as a writer pursuing science journalism.

Case: Tre

Tre is an African American high school junior who said he enjoyed watching science and sci-fi television, reading, and skateboarding. He lives and attends a public school in a distant but established suburb of the city. Tre considers science to be very important to his everyday life, and related to his hobby of skating. He is a regular consumer of science and technology information which he pursues for fun, because he wants to learn more about particular topics, and because they are related to his future educational career goals via books,

magazines (Popular Science and Astronomy), television shows on History or National Geographic channels, websites (Mac Rumors, Apple, Inc., Apple Insiders, IBM), and movies. Tre considers himself a good student and an excellent learner. Science is his favorite subject in school, with particular interests in robotics (in which field he sees his future), nanotechnology, and brain-computer interfaces. He feels there could be "more types of courses" in science at the high school level. On a scale of one to ten, Tre considers his science knowledge compared to that of his peers an 8.5. He defines science as "the rational explanation of everything around us." Tre plans to travel to India following high school before returning to the US to attend college at MIT.

Tre is a self-proclaimed tech-head. He loves fiddling with gadgets and figuring out new shortcuts, as well as sharing this information with others, who rely on him for his insights. He is more interested in sci-fi than "science," and more interested in science than writing. He felt through most of the summer that he had been tricked into participation in SciJourn by a staff person who thought he would be a good candidate and told him he would have more opportunities to experiment with and learn about tech-tools in this program than in other areas of the program. Throughout the summer, Tre struggled with productivity in terms of writing an actual article. His first idea was to write about something he was personally interested in, and fairly current with the audience due to the release of the new movie Star Trek. For his first story pitch, Max (another student) was seated as editor, in the center of the room, and Tre reluctantly joined him.

> Tre: I have two [stories]. Design and how it affects people's mood. Star Trek.
> Max: I don't agree with Star Trek. What are you thinking about design?
> Ben [college-aged supervisor intern]: Go back to Star Trek, but not that?
> Max: The movie or the show?
> Tre: I have seen the movie two times.
> Tammy [adult supervisor]: Maybe you could pull out the science in the movie?
> Ben: What are the specific things about Star Trek and how it influences our lives?
> Tre: It inspires us to invent things.
> Alisha: No it's not a question about people who don't read. Since some people are interested, and some not, what kind of title would you have?
> Tre: I am not sure.
> Nayeli: Tre can you go over again what the article is about?
> Tre: Science of Star Trek. Warp drives. Applying different theories, like Einstein.
> Nayeli: What is the hook?
> Newman: Start with the movies, can you move faster than the speed of light? Then move on to the science behind it.
> Tammy: Science journalism is about using the hooks to get to the science.

Despite encouragement from the group to pursue this further, the direction was too vague for Tre to move forward, and he squandered time and energy looking into it using online sources, never narrowing the concepts far enough for an article. Meanwhile, he continued to isolate himself somewhat from his peers in the group, identifying more with two supervisors with whom he considered himself to share more interests. Throughout

the summer, Tre struggled with "trying to find topics that will interest me, our audience and my supervisors. That's extremely hard because nobody likes anything I'm interested in, except like Alan [the adult editor] or you [Tammy]." Tre's very specific science interests, as expressed in the YEST survey, and observed throughout the summer, were a challenge to his integration into the group. However, Tre's concept of what science actually is seemed to be affected, or perhaps just shifted, through the interactions with others and their story topics.

> Tre: I wish we could talk about stuff that was not so science stuff, but this is a science--I want to talk about like philosophers or something, or just stuff that is, I don't know--
> Tammy: Stuff that's what?
> Tre: I don't know. It's stupid. It's a science organization, so we should talk about science. Like political stuff. That's political science. The science of everything. Science is really broad so you can kind of work around that, but uniforms is definitely not one, unless you consider it social science. That's about it.

When his first topic of choice—the science behind Star Trek—did not pan out, he did not commit well to the topic assigned to him: employee uniforms. Tre did not take seriously the opportunity to interview the program administrator about the topic, and labored for weeks without a final product. He was challenged by the concept of putting ideas to paper before they were polished, and continually distracted by the technology at his fingertips. At the end of the summer, Tre had completed one article ("Uniforms: One Last Distraction on Conformity", which he felt embarrassed about because it "had nothing to do with science") and expressed the hope to never write another article again. Then he was informed that SciJourn was continuing on Saturdays in the schoolyear and in a follow-up interview stated that, "I didn't like writing the article. I think I liked the video more. So I'll start doing video articles." Despite the extensive amount of tech-tools provided by the SciJourn grant, Tre's one suggestion for program improvement at the end of the summer was that the group be provided "higher end" laptops, especially since becoming aware of the size of the SciJourn grant.

Tre's high interest in technology pervaded his personal life. He kept up a nearly obsession-level knowledge of all things Apple, through daily visits to related websites, weekly reading of tech-related books, and reading articles in any technology magazines he comes across. Technology also enabled Tre's pursuit of information outside of school, as illustrated by this example from an end-of-summer read-aloud/think aloud activity.

> Tammy: Do you find this [swine flu in area schools] article interesting?
> Tre: Yeah. It's informative.
> Tammy: Would you read something like this on your own?
> Tre: Yeah. I have a bunch of news apps, so I'm used to checking.
> Tammy: Okay. So you have a bunch of news apps on your phone [an iPhone].
> Tre: Yeah.

This same exercise also illustrated an example of Tre's outside-of-school interest in science topics, in particular. In reading a second article, about the potential effects of chemical fertilizers on wildlife, Tre expressed awareness of the sometimes political nature of science issues.

> Tre: [reading from frog article in read-aloud] "Syngenta, which registered atrazine in the United States and remains a leading manufacturer, declined to comment."
> Tammy: What do you think Syngenta is?
> Tre: Oh kind of like Monsanto. It's like an agricultural company. I don't know.
> Tammy: Why did you say that? What are you thinking about that? You have a funny expression on your face.
> Tre: I was watching this movie, this documentary, about "Food Inc." and how Monsanto has this patented gene or something. And if farmers are using that patented gene they get sued and they can't protect themselves because Monsanto is a corporation and the farmers are just, and they need people trying to sell food. Yeah. It kind of reminds me of that scenario.
> Tammy: How?
> Tre: Because they said they declined to comment. And Monsanto declined to comment on the documentary or when they asked them to interview.
> Tammy: Do you see any other similarities in like the content of the article and the movie that you saw?
> Tre: Yeah, sort of.

Tre's personal interest in technology, and his ability to communicate about it, made him a natural leader of the group as they began to have access to more advanced tools for the project. He was often sharing tricks and tips with the group, such as in the following situation, right after the students received their new Macbooks:

> Tre: What are some tricks? Okay, two finger scrolling. Oh, if you want to add a tab, you can press command and t. Uh, hmm, what else.
> If you push F3, and you have a bunch of windows open, it'll separate them. And if you have a whole bunch, it will separate them.
> Alisha: you could do that on the other one.
> Tre: But it wasn't F3. I think it was F8. Dashboard is just F4 it's just little widgets and things. . . I had another tip. If you put two fingers down and press something, it's like a right click on a mouse. . . If you want to save pictures from the web, you just push command and s and it will ask you what you want to do with the picture.

Oftentimes, if a student—or a staff person—needed assistance doing something on the computer, Tre was willing and able to solve the problem. When Tammy was trying to figure out how to add the toolbar for a website, Tre responded quickly, "I just googled it and found it for Safari, deliciousssafari.com." And, whenever a free moment was available, Tre could be found playing away on the computer, such as was the case one day during a teaching session at the senior center, after which Tre reflected, "I didn't have a partner to work with. But, I was productive; I brushed up on my Apple games." Whether this affinity for technology was a help or a hindrance to Tre's performance as a science writer is not clear; sometimes, the access to technological tools was a distraction.

Tre: [looking at an image on his computer screen, and talking to no one in particular] That's the first cell phone [huge]
Newman: you're supposed to be working on your story
Tre: I'm looking for a picture
Newman: did you send me the article?
Tre: No
Newman: After you send me the article, you can look for a picture.
Tre: OK.

In Tre's case, the results of the YEST survey did seem to paint the picture of reality. Getting to know this student better, and gain further insight into his particular interests, were facilitated by observation of his interactions with peers and production of artifacts, but the overall impression of Tre as a plugged-in, 21st century teen who was defined by the technology with which he interacted was well-described by his survey responses. How Tre made sense of his interactions with science information, and those he considered to share his interests with, remained unknown, due to the distractions he encountered or creates for himself within the SciJourn project. Perhaps delving into video production, as he suggested would be his interest, will further facilitate Tre's full engagement in the SciJourn process and help close the loop between his identity, interests, and performed behavior.

Case: Khadijah

Khadijah is an African American female who lives and attends public school within the city. She is a senior in high school who listed listening to music, hanging out with friends, and eating as the main ways she spends free time. She considers science to be very important to her everyday life, and uses science in the daily activities that involve her body, like getting ready for school/work. Her main source of science and technology information is the Internet. Khadijah considers herself to be an average student in terms of both learning and grades. According to her YEST Survey responses, Khadijah's main interests in school science are chemistry, which she "loves," and space. She is also interested in "the whole thing of technology." She says she is "usually" interested in learning science and technology in school, and "sometimes" outside of school. Comparing her own knowledge of science to that of her peers in high school, Khadijah rated herself a six out of ten. Her career goals include becoming a lawyer, a field in which she believes science will be "somewhat" important, and technology will be very important "because court rooms are becoming more technical."

From the beginning of the summer, Khadijah expressed an interest in journalism—forensic journalism, to be exact. A four-year participant in the youth program, certain of her future as a college graduate, Khadijah could be considered a success story of the program, and soon became seen as such for the SciJourn project, as well. Despite a personal schedule that sometimes conflicted with the work in the program, Khadijah was quick

to finish her first and second articles, and continued pitching and editing others' pitches throughout the summer with enthusiasm.

The stories Khadijah pitched were strongly linked to her personal interests and experiences, and sometimes challenged her own, and the group's, idea of science. For example, as she was doing preliminary Internet research on an article about graduation rates of students in foster care, Khadijah asked Newman, "Does statistics tie into science?" Newman, the project's former professional journalist and managing editor of *The SciJourner* replied, "Yes, that is mathematics. Math is the language of science. Put numbers in your article; that is really good. Don't make up numbers [laughs]." After further research, Khadijah pitched the article idea to others, and showed she had adopted that information in her stance in the fishbowl [editor's circle].

> Khadijah: My pitch is on statistics with foster children – foster care – a lot of people say children in foster care don't graduate or go to jail – so I'm going to look at what statistics say.
> Alisha: What specific statistics?
> Khadijah: Whether they don't graduate.
> Nayeli: How does that relate to science?
> Khadijah: Statistics is science.
> Nayeli: Is that gonna involve any genetics?
> Khadijah: No.
> Newman: Actually, what you're talking about is sociology.
> Jaylen: Yeah [grinning, like "if you say so"]
> Newman: [explains that psychology and sociology are called social sciences]

Others (Nayeli and Jaylen) were skeptical at this point in the summer about social science topics "counting" as science, but Khadijah embraced the social science framing as she continued to write about topics of a social nature. At the end of the summer, she said, "SciJourner is not just about science – we're talking about technology and math" showing that she was distinguishing the three from one another, and also perhaps a connection between her survey response of being less interested in learning about "science" when not in school.

Khadijah expressed more interest and personal connection to technology in her everyday life than in science. In SciJourn, it was rare to observe her utilizing fewer than two technological outlets at a time—listening to music through her headphones while tweeting or typing, facebooking or skyping—were typical behaviors. She was happy to share her knowledge of computers with the residents at the senior center where the teens taught each week, and even went to one woman's room with her to assist with a particular problem:

> The lady needed help putting a screen saver on in her room, and she was teaching me some things and I was teaching her some things, and the screen to her computer is like really retarded. Like the whole computer. . . It didn't happen. It wouldn't work. I have never seen a computer that there was not a screensaver or a backdrop or anything. Then I went on the internet to find a screensaver, but it was like a really old screen. Some old computer screen. And then like, after we tried that, we're just going to go to yahoo, right click save, and put it as background. That didn't work. So. . .

On a field trip to a television studio, she asked specific questions about the tools used to produce the shows that reflected this interest. In terms of an article, however, she chose to write a human interest piece rather than something focused on the technology at the station, explaining during her pitch of the story that, "for people like me, who aren't really interested in it, what's important is having a job you're really comfortable in, and that you like it."

Honing in on what exactly is of interest was a challenge after she wrote the very personal article about foster care children's graduation rates, which she considered her best article. The following conversation between Khadijah and two supervisors illustrates the point that finding a topic of interest, and then identifying the connections to science within that subject was a more common approach for this student than first expressing an interest in writing an explicitly "science" or "technology" article.

> Khadijah: I have been brain dead since I started to write.
> Tammy: Well, what do you think you might want to write about?
> Khadijah: That's where I'm lost.
> Tammy: Well, what are you interested in?
> Khadijah: I'm interested in food.
> Newman: Somebody's already pitched food.
> Tammy: Yeah, that's a popular subject. What else are you interested in? What would you, if you saw something on CNN, would you actually stop to look at?
> Tammy: What about girls who play sports on boys' teams?
> Newman: Khadijah, do something that's personal.
> Khadijah: Well, that is personal. I'm a girl, and I wrestle.
> Tammy: Do you get in trouble for it?
> Khadijah: Well, boys at my school say, you can't mess with her, she wrestle.
> Khadijah: We get hurt more.
> Newman: Can you find statistics that support that? Aren't there sports association at the high school level? I know in football, high school football, they get hurt more than college players.
> Tammy: I've heard more girls wrestle than. I've had more girls
> Jaylen: Girls like wrestling people. They're violent.
> Newman: Are there higher rates of injuries, like for real? I'm sure they're tracking this stuff.
> Tammy: I mean, is that interesting enough for you to follow?
> Khadijah: It is, but what if I can't find the statistics?
> Newman: Well then you have to go talk to people about why they think it's true.
> Khadijah: like, anytime I write something, it's because I've got passion about it. Like poetry is because I have feelings about it.

While Khadijah recognizes the connections between her physical actions and daily activities and science/technology, her motivation to pursue information about either topic is tied closely to her personal interests. Her behavior within the SciJourn project, in terms of productivity, were linked directly to her personal identity and passions; interest in science and technology were relevant, but less explicit in her projects than some of the other participants' work.

The science movies, television, and/or internet sites this student views "for fun" may also be a better reflection of Khadijah's identity as a 21st-century consumer of information than an interest in pursuing information on any particular science topic. While she expressed strong interests in chemistry and astronomy in the YEST survey, nothing in Khadijah's writing or observed behavior as a SciJourn participant supports this notion. For a student willing to delve into topics of highly personal nature for journalistic inquiry within a science-focused setting to neglect her self-reported favorite subject matter highlights the issue of relying on one measure to fully and completely measure a complexly defined construct such as science engagement. While the observation data for these cases elaborates on many of the items measured by the survey, some specific aspects, such as Khadijah's reported and enacted science interests, illustrate the lack of consistency that social science researchers must hope to limit through instrument design and check via use of multiple data sources.

Case: Alisha

Alisha is an African American high school senior, attending a public magnet high school in the city. She took college prep courses and courses necessary for Emergency Medical Technician (EMT) certification, all through the public school. She stated she was very interested in school, rating herself with good grades and good at learning. She spent her free time listening to music, reading, and sleeping. She commented that her professional goals included being a medical student and eventually a doctor, preferably a pediatrician. She noted that she will use science and technology in her career on a daily basis to find the answers to questions that go unsolved and for the ability to heal patients. For the majority of her YEST survey answers, regarding her interaction with science and technology, she stated her interactions were mostly "required" and/or "assigned." This should not be taken to imply that she resists such required engagement with science; on the contrary, she believes science should be included more often in schools.

Although Alisha was highly vocal, with a higher frequency of verbal interaction than the other teens, she frequently displayed her knowledge by answering questions presented by those in charge. In one such instance, Ben, the college intern participating in the program, was leading a review lesson on the 5 W's of journalism. Here, Alisha perfectly answered Ben's questions by recalling the knowledge previously learned, "The who was the journalist, our what is what the introduction was, our when was also the introduction, like at the beginning of the article, and our why was to grab the readers' attention." It was apparent that Alisha was a very good student within the conventionality of formal education. She seemed to flourish in a highly structured system of formal schooling, as she noted on the survey that she is a good student with good grades. Alisha seemed to have some limitations in a system such as the summer youth program that allowed for so much creativity and freedom. She frequently stated the following:

> Taking notes ain't the hard part. The writing is the hard part. I don't like forced writing. Well, I guess, like, since, I wrote like two, and I … coming up with a topic and writing about it on my own, and this like forced writing, I really don't like forced writing. It make my head hurt. I'm serious, forced writing is a pain. In SciJourn, I have to write from a general sense.

Alisha connected her behavior and identity with science, but her primary interest was instrumental, meaning she viewed the writing as a means to an end. In a follow up interview with Alisha, she described her views on the process of writing and editing with a professional editor,

> Alisha: Yeah. Like all of the teens, including myself, we were so used to writing papers at school and we weren't descriptive answering things and our titles didn't make any sense about the article. And I guess it's like we really didn't have a clear insight on how to write articles at first.
> Researcher: In what ways did Alan's method of criticism impact your writing?
> Alisha: It impacted my writing because now I can see, I guess my sources are reliable or when something doesn't make any sense, or if it's irrelevant altogether.
> Researcher: What did you learn through the process of responding to Alan's edits and rewriting your articles, through that getting the edits and then rewriting?
> Alisha: Even though I had a good story, it could be better and I could make it better....
> Researcher: What feedback did you find the most helpful?
> Alisha: Constructive criticism feedback like just not to take everything personally because you're writing the article for someone else. It's not for you.

Alisha never took ownership of her work; she mainly wrote the article to satisfy the requirement. She focused on the assignment at hand, successfully made corrections, and submitted the paper but didn't relate her behavior and interest beyond what was required. Only after she saw her name printed, did she show pride, by stating "I was excited. I wanted a lot of people to read it. I was like, look it's my name on the sign."

Alisha rarely shared her expert knowledge with others. The only incident noted throughout the summer program, was when the group of teens were discussing the death of Michael Jackson, in which Alisha stated, "...he did NOT have a heart attack." She then discussed the difference between cardiac arrest and heart attack with the group. Later that day, Jaylen used the information for his pitch:

> So this idea just came to me when you were talking about the science of Farrah Fawcett, and we could team up, and I could write about Michael Jackson and the difference between cardiac arrest and heart attacks, and how they are different. Because there was a lot of confusion on that on Facebook.

Upon reviewing and discussing Alisha's case, we realized the need to include a question on the YEST survey regarding the sharing of science and technology information and knowledge with others (See Question 21 in YEST Survey).

In conjunction with Alisha's interest in science and her career goals in the medical field, she chose to write her second article (and final one of the summer) on healthy eating choices. During her pitch, she stated the following:

> I have a story about obesity. It's a problem in the US, and it's really a problem in Mississippi. It's like the largest state, I guess. I don't want to say fat. They have the highest rate of obesity it's like 43%. So, what can we do to solve obesity in the United States? Because the youth are like, and babies are being tested for clogged arteries and that shouldn't be.

In a follow up interview, Alisha stated the healthy eating choices article to be her favorite one, being that it "gets the reader aware of what they eat...because I like to eat. I guess since I'm a teenager, anything I eat isn't necessarily good for me. So I guess it's like turning over a new leaf." Alisha felt she wanted the reader to "come away with that eating snacks and different things is okay in moderation, but more fruits and vegetables, and protein and wheat and all that needs to be pushed into the diet more."

Throughout the summer science program, Alisha's YEST Survey responses reflected her interest, behavior, and identity with science and technology. While not thriving in terms of freedom and creativity, Alisha was very comfortable in a formal schooling system, where she was able to project herself forward by being a "good student." She successfully completed two science articles because it was "required" and "assigned." As a student, her completed assignments centered around her behavior and identity, yet she rarely showed any interest or progression beyond what was required.

Summary

There are many challenges of only using one instrument to assess a complex construct such as the engagement with science and technology. In order to meet that challenge, we compared the youth's daily interactions with science and technology and evaluated that against their responses to the YEST survey. These individual case studies represent the comparison of the four individuals and their interactions with science and technology throughout the summer program to provide validation for the YEST survey. By doing this, we hope to develop and refine this instrument that will be implemented with large numbers of individuals, where it is not physically possible to observe each individual's daily interactions with science and technology. The purpose of this analysis is to support the development and modifications of the YEST survey and show that it is possible to use only one instrument.

Survey Reliability and Validity

For any survey to be useful in research, it must be shown to be sufficiently reliable and valid for the collection of data from the intended sample. In addition to following Fowler's (2009) advice for total

survey design as we considered our potential sample and mode of data collection, and evaluated individual survey questions, efforts have been, and continue to be made, to determine the reliability and validity of the current YEST Survey according to guidelines provided by Litwin(1995).

Validity.

The group of seven teens involved in the pre-testing of the YEST Survey provided feedback through the individual interview and think-aloud administrations of the instrument, as well as a focus-group discussion, on the face and content validity of the measure. In addition, the SciJourn research team, as well as a university survey expert, and the teacher-participants in the grant project provided feedback on the overall appearance, content, and length of the survey. These insights were considered in the current survey design, resulting in the chart format of questions 15 through 21to reduce the overall length of the survey (in pages), as well as the amount of time the survey took participants to complete. Teen feedback led to the omission of a question about the use of the radio as a source of science/technology information. Observed lack of clarity and difficulty of interpretation of responses to a question about "types of classes" participants take in school intended to assess student achievement led to removing that question, as well. Teachers who have administered the latest version of the survey found it less overwhelming to their students in terms of length, and less time consuming for students to complete.

The purpose of the current study has been to validate the extent to which the YEST Survey effectively measures the construct of high school student engagement in science and technology as we have defined it. Consideration of the cases of four participants, alongside their responses to the survey show that overall, the survey resulted in accurate description of the individuals' engagement in science outside of school; disconnects between a specific student's interests (for example, Khadijah's stated interest in chemistry and astronomy) and behaviors (lack of reported or observed participation in activities related to chemistry or astronomy) were shown in both survey and observation results. Further evidence for the construct validity of the YEST Survey will be obtained as the instrument is used with larger samples and in a variety of studies.

Reliability.

A test-retest administration of the YEST Survey is presently underway with a group of 50 non-intervention teen participants. This data will be analyzed to calculate an r value for the instrument's reliability. We aim for an overall instrument score correlation coefficient of .70 or greater, in accordance with Litwin (1995). As illustrated in Table 1, the survey has been designed with multiple questions

related to each aspect of engagement we specify. The test-retest data will also be used to calculate a Cronbach's alpha for each of these groups of questions, providing evidence of the survey's internal consistency reliability.

Aspect	Number of Questions	Types of questions
Interest	7	Level of interest in school, science, technology Specific areas of interest in science and/or technology
Behavior	17	Frequency of activities related to science and/or technology Ways of spending free time Information sources utilized
Identity	13	Activities in everyday life related to science and/or technology Views of self related to science and/or technology Future plans

Table 1. Design of survey for assessing three aspects of engagement.

Scaling and scoring.

In order to allow for scoring of surveys by more than one researcher, a standardized codebook has been created for use by all members of the research team. Once initial pilot survey data has been processed, factor analysis will be conducted to ascertain whether the questions we designed to measure components of our three key aspects of engagement are actually loading in the intended manner. The results of that analysis, as well as the results of the above pre-testing of questions and case studies, will be used to make decisions about omitting or adding questions in the final version of the instrument. A scoring guide will also be created for the version of the YEST Survey to be utilized in subsequent studies of the SciJourn project.

Conclusion

Science literacy is a shared goal of most organizations supporting and examining science education (e.g., AAAS, 1989; National Association of Research on Science Teaching, 2010; National Academy of Sciences, 1996; U.S. Department of Education, n.d.), as well as the project of which this study is a part. Engagement is an important means to achieve science and technology literacy, not just in school but throughout young people's lives. This study seeks to clarify and assess the degree to which youth are engaged with science and technology, and clarify the relation of this engagement with science literacy.

In order to improve the teaching and learning of science and technology for youth, educators should better understand how youth are engaged with these realms in their daily lives. The development project described in this paper stands to provide a more valid measure of engagement than is presently available. With this tool, programs can better connect instruction with individuals' already existing engagement, rather than

acting as if students are blank slates. Such individualized instruction building on prior knowledge and experiences stands to better promote science literacy gains. Once educational interventions designed to promote both science literacy and engagement are carried out, the YEST survey can be used to measure an important impact of in-school and out-of-school programs, and to inform instructional practice that better integrates science and technology learning into the lives of today's youth.

References

American Association for the Advancement of Science (AAAS). (1989) *Science for all Americans*. Washington, D.C.

Azevedo, F. S. (2004). What does it mean to be interested in a practice? In Y. B. Kafai, Sandoval, W. A., Enyedy, N., Nixon, A. S., & Herrera, F. (Ed.), *Proceedings of the Sixth International Conference of the Learning Sciences 2004: Embracing diversity in the learning sciences* (pp. 10-11). Mahwah, NJ: Lawrence Erlbaum Associates.

Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecology perspective. *Human Development, 49*, 193-224.

Basu, S. J., and Barton, A. C. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching*, *44*(3), 466-489.

Durant, J. (1999). Participatory technology assessment and the democratic model of the public understanding of science. *Science and Public Policy, 26*(5), 313-319.

Falk, J.H., Brooks, P., & Amin, R. (2001) Investigating the role of free-choice learning on public understanding of science: The California Science Center L.A.S.E.R. project. In J.H. Falk (Ed.), *Free-choice science education: How we learn science outside of school,* (pp. 115-132). New York: Teachers College Press.

Falk, J.H., Storksdieck, M., & Dierking, L.D. (2007). Investigating public science interest and understanding: Evidence for the importance of free-choice learning. *Public Understanding of Science, 16*, 455-469.

Fowler, F.J. (2009). *Survey research methods*. Thousand Oaks, California: SAGE Publications, Inc.

Furman, M., and Barton, A. C. (2006). Capturing urban student voices in the creation of a science mini-documentary. *Journal of Research in Science Teaching, 43*(7), 667-694.

Korpan, C.A., Bisanz, G.L., Boehme, C., & Lynch, M.A. (1997). What did you learn outside of school today? Using structured interviews to document home and community activities related to science and technology. *Science Education, 81,* 651-662.

Lau, S., & Roeser, R. W. (2002). Cognitive abilities and motivational processes in high school students' situational engagement and achievement in science. *Educational Assessment*, *8*(2), 139-162.

Lee, O. & Anderson, C.W. (1993). Task engagement and conceptual change in middle school science classrooms. *American Educational Research Journal, 30*(3), 585-610.

Lichtenstein, M. J., Owen, S. V., Blalock, C. L., Liu, Y., Ramirez, K. A., Pruski, L. A., et al. (2008). Psychometric reevaluation of the scientific attitude inventory-revised (SAI-II). *Journal of Research in Science Teaching*, *45*(5), 600-616.

Litwin, M. S. (1995). *How to measure survey reliability and validity*. Thousand Oaks, CA: SAGE Publications, Inc.

Markowitz, D. G. (2004). Evaluation of the long-term impact of a university high school summer science program on students' interest and perceived abilities in science. *Journal of Science Education and Technology*, *13*(3).

Martin, A. J. (2005). Exploring the effects of a youth enrichment program on academic motivation and engagement. *Social Psychology of Education*, *8*(2), 179-206.

McCallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., Needham, C., & Wiehe, B. (2009). *Many experts, many audiences: Public engagement with science and informal science education*. Washington, DC: Center for the Advancement of Informal Science Education (CAISE).

Miller, J.D. (1992). Toward a scientific understanding of the public understanding of science and technology. *Public Understanding of Science, 1,* 23-26.

Miller, J.D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science, 7,* 203-223.

National Academy of Sciences. (1996) *National Science Education Standards*. National Academy Press: Washington, D.C.

National Association of Research on Science Teaching (2010). NARST mission statement. Retrieved February 11, 2010 from http://narst.org/about/mission.cfm.

Olitsky, S. (2007). Promoting student engagement in science: Interaction rituals and the pursuit of a community of practice. *Journal of Research in Science Teaching*, *44*(1), 33-56.

Polman, J. L., and Miller, D. (2008). Sociocognitive apprenticeship: Mediating practices and identities. In G. Kanselaar, V. Jonker, P. A. Kirschner, & F. J. Prins, *International Perspectives in the Learning Sciences: Cre8ing a learning world. Proceedings of the Eighth International Conference for the Learning Sciences – ICLS 2008*, pp. 3-115 – 3-116. Utrecht, Holland: International Society of the Learning Sciences.

Polman, J. L., and Miller, D. (in press). Changing stories: Trajectories of identification among African American youth in a science outreach apprenticeship. *American Educational Research Journal*.

Polman, J. L., Saul, E. W., Newman, A., Farrar, C. (2008). Science literacy through science journalism. Unpublished proposal to the National Science Foundation.

Polman, J. L., Saul, E. W., Newman, A., Farrar, C., Singer, N., Turley, E., Pearce, L., Hope, J., and McCarty, G. (2010, July). A cognitive apprenticeship for science literacy based on journalism. Symposium to be presented at the International Conference of the Learning Sciences, Chicago.

Preczewski, P. J., Mittler, A., Tillotson, J. W. (2009). Perspectives of German and US students as they make meaning of science in their everyday lives. *International Journal of Environmental and Science Education* 4(3).

Rosenzweig, R., and Thelen, D. (1998). *The presence of the past: Popular uses of history in American life*. New York: Columbia University Press.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research, 95*(6), 323-332.

Thompson, J.J. & Windschitl, M.A. (2002, April). *Engagement in science learning among academically at-risk girls: Sense of self and motivation to learn across learning contexts.* Paper presented at American Education Research Association, New Orleans, LA.

United States Department of Education, Institute of Education Sciences (n.d.). Glossary. Retrieved August 12, 2009 from http://nces.ed.gov/programs/coe/glossary/s.asp

Zimmerman, H. T. & Bell, P. (2007, April). Seeing, doing, and describing everyday science: Mapping images of science across school, community, and home boundaries. Paper presented at National Association of Research in Science Teaching (NARST), New Orleans, LA.

Acknowledgments

The authors thank the National Science Foundation (under grant number DRL-0822354) for funding this research. The statements made and the views expressed are solely the responsibility of the authors.

Appendix

Youth Engagement in Science and Technology Survey

Name: _____Date:_____

The following survey is designed to find out ways you are engaged with science and technology. It should take you 15 minutes or less. There are no right answers; we just want to know about your perspective and experience. Some questions may ask about memories that you cannot recall—if you can't remember quickly, just say so and go on to the next question.

I. Participant Information

1. Teacher name: _____

2. Are you... Male or Female (Circle one)

3. Is English the primary language spoken in your home? (Circle one) YES NO

   If no, what is the primary language spoken in your home? _____

4. Which of the following ethnic group or groups do you identify with? (Check all that apply.)

   - ☐ American Indian or Alaska Native
   - ☐ Asian American
   - ☐ Black or African American
   - ☐ White or European American
   - ☐ Hispanic or Latino
   - ☐ Native Hawaiian or Other Pacific Islander
   - ☐ Other (Please specify: _____)

5. What is the zip code at your home (the place where you live most of the time)? _____

6. What grade are you in? (Circle one.) 9th 10th 11th 12th

7. What school do you attend? _____

8. What are the three main ways you spend your free time? (Please list)

   1. _____
   2. _____
   3. _____ _____

II. Science & Technology Activities

9. What activities in your everyday life are related to science? (Please list.)

10. How important is science to your everyday life? (Circle one.)

1	2	3	4
Not at all important	Somewhat	Important	Very important

11. When you are looking for information about science, how often do you use each of the following? (Circle one answer for each resource.)

Teacher	Always	Sometimes	Never
Family member	Always	Sometimes	Never
Textbook	Always	Sometimes	Never
A different kind of book	Always	Sometimes	Never
Internet	Always	Sometimes	Never
Magazine/Newspaper	Always	Sometimes	Never
TV or Movie	Always	Sometimes	Never

12. What activities in your everyday life involve technology?

13. How important is technology to your everyday life? (Circle one.)

1	2	3	4
Not at all important	Somewhat	Important	Very important

14. When you are looking for information about technology, how often do you use the following? (Circle one answer for each resource.)

Teacher	Always	Sometimes	Never
Family member	Always	Sometimes	Never
Textbook	Always	Sometimes	Never
A different kind of book	Always	Sometimes	Never
Internet	Always	Sometimes	Never
Magazine	Always	Sometimes	Never
TV or Movie	Always	Sometimes	Never

For the following items, please respond by checking the best description of how often you've done each of the activities, *within the last three months.* For any activity you have done, check all of the reasons why you did that activity.

How often have you…	Related to SCIENCE	Reason for doing	Related to TECHNOLOGY	Reason for doing
15. Read a **book**	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests
16. Read a **magazine or newspaper article(s)**	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests
17. Watched a **TV show(s) or movie(s)**	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests
18. Visited a **website**	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests

How often have you…	Related to SCIENCE	Reason for doing	Related to TECHNOLOGY	Reason for doing
19. Taken part in a **club or other group activity** devoted to learning	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests
20. visited a **museum or other site**	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests
21. provided an opinion to someone else about a topic	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests	☐ Not at all ☐ Once ☐ Monthly ☐ Every two weeks ☐ Weekly ☐ Daily	☐ Assigned for a class/related to a school project ☐ Required for work ☐ Fun or personal enjoyment ☐ Wanted to learn more about the topic ☐ Used the information to make a decision ☐ Related to my future schooling or career interests

III. Interests

22. How interested are you in school? (Check one.)
    - ☐ I am not interested in any subjects
    - ☐ I am a little bit interested in a few subjects
    - ☐ I am interested in some subjects, but not in others
    - ☐ I am interested in most subjects
    - ☐ I am very interested in school

23. How do you rate yourself as a student, in terms of grades? (Circle one.)

    Poor Fair Average Good Excellent

24. How do you rate yourself as a student, in terms of learning?
Poor Fair Average Good Excellent

25. How do you feel about science in school?

26. How interested are you in learning science *in* school?
- ☐ I have no interest
- ☐ I rarely have interest
- ☐ I find science interesting sometimes
- ☐ I usually am interested
- ☐ Science is my favorite thing to learn about in school

27. How interested are you in learning about science *outside of* school? (Check one.)
- ☐ I have no interest
- ☐ I rarely have interest
- ☐ I find science interesting sometimes
- ☐ I usually am interested
- ☐ Science is my favorite thing to learn about outside of school

28. How interested are you in learning about technology *in* school? (Check one.)
- ☐ I have no interest
- ☐ I rarely have interest
- ☐ I find technology interesting sometimes
- ☐ I usually am interested
- ☐ Technology is my favorite thing to learn about in school

29. How interested are you in learning about technology *outside of* school? (Check one.)
- ☐ I have no interest
- ☐ I rarely have interest
- ☐ I find technology interesting sometimes
- ☐ I usually am interested
- ☐ Technology is my favorite thing to learn about outside of school

30. What, if any, specific aspects of science and technology do you find interesting?

31. What can someone who is good at science do?

32. On a scale of 1 to 10 (where one indicates very low, five is average, and ten very high) rate your knowledge of science compared with the "average high school student." (Circle one.)
1 2 3 4 5 6 7 8 9 10

33. Do you ever see yourself as a scientist? (Circle one.) YES NO

If yes, please describe when and where.

IV. Future

34. a. What do you see yourself doing 5 years from now?

b. 10 years from now?

35. a. How important will science be in your future education and profession?

1	2	3	4
Not at all important	Somewhat	Important	Very important

b. In what ways will science be important in your future education and profession?

36. a. How important will science be in your future personal life?

1	2	3	4
Not at all important	Somewhat	Important	Very important

b. In what ways will science be important in your future personal life?

37. a. How important will technology be in your future education and profession?

1	2	3	4
Not at all important	Somewhat	Important	Very important

b. In what ways will technology be important in your future education and profession?

38. a. How important will technology be in your future personal life?

1	2	3	4
Not at all important	Somewhat	Important	Very important

b. In what ways will technology be important in your future personal life?