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The Motivational and Information Needs of Young Innovators: Stimulating Student Creativity and Inventive Thinking

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> "True inquiry should result in new understandings for learners, but not final answers, because during the process, learners should naturally re-stimulate their curiosity and discover new questions and intriguing areas to pursue in future investigations. Perhaps there is no better result from an inquiry investigation than the comment, 'Ah, I understand, but now I wonder. . .'" (Small et al. 2012, 3).

Abstract

Innovation is the essence of the American spirit. In the twenty-first century, it will be the innovative thinkers who will make the greatest contributions to our society, find cures for diseases, create technologies that enrich our lives, and find innovative solutions to the world's problems. Schools must provide more opportunities for students to create, innovate, and explore their ideas; the school library is the one place in the school in which all children can think outside the box, seeking solutions to real-world problems that interest and challenge them. This article describes a study conducted by a research team at Syracuse University's Center for Digital Literacy, in collaboration with the Connecticut Invention Convention, investigating the attitudes toward innovation activities, motivational supports, and information needs of young innovators in grade 4–8 as they progressed through the innovation process. Implications of this initial research are that school librarians have an opportunity to (1) provide "innovation spaces" that foster curiosity and exploration within their libraries and (2) become role models or "innovation mentors" to all students, supporting their motivational and information needs throughout the innovation process.

Introduction

Innovation is the essence of the American spirit. Rosabeth Moss Kanter (1983) defined innovation as the generation, acceptance, and implementation of a new idea, process, product, or

service or a new or improved version of an existing product or service. Charles W. Prather and Lisa K. Gundry (1995) considered innovation a way to solve a problem that enables achievement of a new, higher level of performance. Innovation requires using problem-solving skills and persistence to find viable solutions to that problem (Small, Costa, and Rothwell 2011). Twenty-first-century jobs require creativity and innovation, two qualities that U.S. schools fail to address. While our schools often focus on curricula, standards, and testing, school educators (and particularly school librarians) need to provide more opportunities for students to be creative and innovative and to explore their ideas.

A position paper from the American Association of School Librarians states "To be prepared for a future characterized by change, students must learn to think rationally and creatively, solve problems, manage and retrieve information, and communicate effectively" (1995, 1). In the twenty-first century, it will be the innovative thinkers who will make the greatest contributions to our society, find the cures for diseases, create the technologies that enrich our lives, and find innovative solutions to the world's problems.

With today's growing emphasis in schools on curriculum, standards, and testing, it becomes increasingly more likely that students will develop a "good enough" mentality in which they no longer stretch their imaginations, seek answers to questions that go beyond the curriculum, or allow themselves to explore the perplexing issues that pique their curiosity. Nicholas Colangelo et al. found that "inventiveness is a talent not usually identified and nourished in the traditional curriculum of schools" (2003, 288). Rob Stokoe has stated, "As we grow up, we start believing the answers are more important than the questions. Yet adult creativity is still powerful; there is just not enough of it; it can be said that the creative adult is the curious child who survived" (2012, 57).

It is in this context that the school library becomes the *one* place in the school in which all children are allowed to think outside the box, learning essential inquiry skills while applying their creativity and innovative thinking to seek solutions to real-world problems (personal, community, global) that interest and challenge them. School libraries have the potential to be transformed into "innovation spaces" where students go to satisfy their curiosity, explore their ideas, and creatively apply their inquiry and inventive-thinking skills. The purpose of this research study was to investigate ways in which school librarians might address the motivational supports and information needs of young innovators.

Background

Over the past four decades, there has been steady erosion in investment in the kind of brainpower that keeps our nation competitive—and a consequent decline in the curiosity, ingenuity, and inventiveness of American entrepreneurship, which once characterized the American spirit. Businesses complain of a lack of innovation and creativity in their employees and a lack of imagination in their customers to envision innovative new products that address their emerging needs or desires (Goldenberg et al. 2003). Marc Tucker, president of the National Center on Education and the Economy, has predicted that future American jobs will "put an enormous premium on creative and innovative skills, seeing patterns where other people see only chaos" (Wallis and Steptoe 2006, 52).

Several years ago Mark R. Costa, Susan L. Rothwell, and I developed an innovation continuum to explain the progression from curiosity to innovation to entrepreneurship (Small, Costa, and Rothwell 2011); see figure 1. Creativity, the most basic form of innovation, is the creation of

something new or novel, even if it is novel only to its creator (Weisberg 2006). The creative experience can end there, with the production of an outcome or product. For creativity to lead to innovation, it should be a novel product or service or improve on an existing product or service and have utility and the potential to lead to acceptance and implementation by others (Kanter 1985). Innovation leads to entrepreneurship when (1) the innovator seeks a market for the product or service and (2) the innovation is accepted or adopted by others as a result of active dissemination (Small, Costa, and Rothwell 2011).

Figure 1. The innovation continuum (Small, Costa, and Rothwell 2011).

School libraries offer an ideal environment for fostering discovery and innovation, acting as "inquiry learning labs" (Knodt 2010) or even "learning playgrounds" (Bush 2008). To survive, librarians must dynamically and ruthlessly pursue new roles (Fourie 2004). Fortunately, school librarians are well suited to support young innovators because school librarians (1) teach digital literacy and technology-fluency skills, critical elements for the support of children's creativity and inventiveness (Lewis 2009); (2) tie these activities to Common Core State Standards across any and all subject areas and grade levels; and (3) offer a flexible schedule that allows more diverse activities. Marilyn Arnone and I have written that children's curiosity has not changed but the ways in which they act on that curiosity has, and, as a result, information and digital literacy skills have become even more critical for supporting the curious, creative child (Arnone and Small 2013). However, we know very little about (1) the factors that contribute to or support the innovation process, (2) who and what motivates or "demotivates" that process, and (3) what role school librarians might play in facilitating that process.

This article describes a research study conducted at Syracuse University's Center for Digital Literacy (CDL), in collaboration with the Connecticut Invention Convention (CIC), an internationally recognized educational organization designed to develop, encourage, and enhance critical-thinking skills in students in grades K–8 in Connecticut schools through invention, innovation, and entrepreneurship <www.ctinventionconvention.org>. This study investigated the motivational supports and information needs of young innovators in grades 4–8 as they progressed through the innovation process from creativity to innovation (and, potentially, in the future, to entrepreneurship).

The following research questions formed the basis of this study:

1. In what ways are participation in innovative activities and students' intrinsic motivation for innovating related?
2. What are students' information needs (resources, skills, technologies) during the innovation process?
3. What roles do teachers and librarians play in supporting and facilitating student innovation?
4. Is there a relationship between participation in innovation activities and interest in STEM learning?

Methods

Introduction

This research study used a mixed-methods approach that included an online survey on SurveyMonkey.com and audio-recorded telephone interviews.

Participants

Recruitment

To solicit parental permission for children in fourth through eighth grades to participate in this study, e-mail and website messages were sent to teachers and parents of students in schools participating in the Connecticut Invention Convention, since teachers generally led participation in their schools and most parents worked with their children to create their final innovation. No child participated in the study unless that child also consented to participate.

Demographics

A total of ninety children in grades 4–8 throughout the state of Connecticut signed onto the survey at SurveyMonkey.com; eighty-four children completed the survey. (Only completed surveys were analyzed.) Of those who completed the survey, 57 percent (48) of participants were girls, 43 percent (36) were boys. Seven percent (6) of participants were in grade 4, 31 percent (27) in grade 5, 30 percent (26) in grade 6, 20 percent (17) in grade 7, and 12 percent (10) in grade 8.

Survey participants were purposefully selected for telephone interviews from those who had completed the online survey; selection was based on gender, grade level, and location. Parents of only two fourth-graders gave permission to interview their children, and one of those fourth-graders dropped out prior to the start of the first interview session. Therefore, a total of nineteen child inventors (ten boys, nine girls) were interviewed, including one in grade 4, four in grade 5, seven in grade 6, three in grade 7, and four in grade 8; see table 1 (fictional names used).

Table 1. Interview participants' fictional name, grade level, and gender.

Name	Grade Level	Gender
Jacob	4	Male
Fiona	5	Female
Christopher	5	Male
Adam	5	Male
Steven	5	Male
Sabrina	6	Female
Anne	6	Female
Jonathan	6	Male
Brandon	6	Male
Teddy	6	Male
Rebecca	6	Female

Madison	6	Female
Debbie	7	Female
Cathy	7	Female
David	7	Male
Brianna	8	Female
Paul	8	Male
Gavin	8	Male
Rosemary	8	Female

Research Instruments

Overview

This research study used online surveys and telephone interviews to collect data from fourth- through eighth-grade participants in the statewide invention convention. An electronic three-part survey was developed and posted to SurveyMonkey.com.

Online Survey

The online survey consisted of three parts; see Appendix A: Young Innovators Online Survey. Part I asked for demographic data, a description of the respondent's invention, and why he or she created it. Using an adapted version of Edward L. Deci and Richard M. Ryan's Intrinsic Motivation Inventory, part II of the survey asked participants about their motivation as they were creating their inventions; see Appendix B: Young Innovators Intrinsic Motivation Inventory. Part III focused on information-related needs. (Additional details about the survey are provided in context in the "Results" section.)

Telephone Interviews

An interview protocol consisting of twelve questions focusing on the information and motivational aspects of innovation was used; see Appendix C: Young Innovators Interview Questions. Probes and follow-up questions were added, where appropriate. Two graduate research assistants who were trained in interviewing and probing techniques conducted and recorded all interviews. When all interviews were completed, they were transcribed for data analysis.

Procedures

This study was conducted in spring 2012 and again in spring 2013, following the statewide invention convention. Students were instructed that if they had completed the survey in 2012, they should not participate in 2013, and an analysis of names of participants indicated none did. Before any data were collected, a letter was sent to the parents of invention contention participants, describing the study and asking their permission for their child(ren) to participate.

After parental permission was received, an e-mail with the survey's URL was sent to parents along with directions for their children's participation. After each survey period was completed, telephone interviews were conducted.

Survey data were analyzed using descriptive statistics.

Interviews averaged approximately twelve to fifteen minutes in length. When all interviews were completed, data were coded and content analyzed.

Results

Descriptions of Inventions

Responders were asked to describe their inventions; their descriptions reflect a remarkable sophistication, social sensitivity, and altruism while displaying the delightful perspective of a child. A few examples are:

- My invention is a protective military mask. It prevents any bullets or fragments from the skin. It also keeps you cool in the desert and hot in the cold. This also can hold radios or can fit on a helmet. It does include goggles because they already invented bullet proof goggles. This mask is better than any other mask because it fits the soldier's needs.
- My invention is ... a remote control that would help people with Treacher Collins Syndrome. People with Treacher Collins Syndrome are born without ears, but have a hearing aid surgically implanted where their ear would be. The remote would have two buttons. One that would allow them to hear in broadband, which is when they can hear everything. And one button for single band, which is when they can hear only one specific noise. And there is a dial to turn the volume up and down. There's also a keychain attached to make it easily portable.
- I made a desk that could change its height and width for people with disabilities or in wheelchairs. I created this because I've known people with disabilities or people who were in wheelchairs who had a hard time sitting at their desks in school because the desks weren't adjustable.
- I have created edible cupcake wrappers. They are an edible liner that the cupcake is baked inside of; you can just eat the whole thing, rather than unwrapping a liner and then indulging. It is made from edible wafer paper. This is convenient, and environmentally friendly.

Motives

Interviews averaged approximately 12–15 minutes in length. When all interviews were completed, data were coded and content analyzed.

Interview participants were asked how and why they first got involved in innovation activities. Most respondents said a teacher told them or they heard an announcement at school. Jacob stated that he "liked the idea of getting rid of problems and doing things to make life easier." Rosemary said that whenever she was annoyed at something, she would try to solve the problem with either an invention or just an improvement. Paul agreed, stating that inventing "sounded cool" because he could help make people's lives easier. Jonathan explained that he "likes figuring out how things work," adding inventing was "in my blood." Sabrina said her father, who is an engineer, inspired her to invent.

Some interviewees said they were required to participate; for others, participation was voluntary. Brianna said she got involved because it seemed interesting and novel and because it was related to science and math, which she liked.

When asked why inventing was enjoyable (beyond helping people), responses demonstrated an affinity for creative problem solving (e.g., "get an idea and make it useful," "think of your own solution that no one has thought of," "use your imagination").

Research Question #1: In What Ways Are Participation in Innovation Activities and Students' Intrinsic Motivation for Innovating Related?

Examples of Motives

The online survey asked participants to describe why they created that particular invention. The frequently unselfish and highly personal and occasionally humorous responses reflect students' altruism and strong intrinsic motivation.

- I am interested in the military, and one day I saw this picture of a soldier with a ruined face because he got hit from a bullet in the face and survived. I hoped to protect the face so that this will never happen again. (*inventor of the protective military mask*)
- I created this invention because my classmate has Treacher Collins Syndrome (TCS). When he is in the movie theater, and a friend wants to whisper a comment to him, he can't hear him because he has no control over broadband and singleband. With the remote control that would change. (*inventor of remote control that would help people with Treacher Collins Syndrome)*
- I created this because I've known people with disabilities or people who were in wheelchairs who had a hard time sitting to their desks in school because the desks weren't adjustable. *(inventor of adjustable desk)*
- I created this invention for convenience and because it will help reduce trash. I love making cupcakes, and when I noticed my dog eats the whole cupcake (inedible wrapper and all) I wondered how I can make it so that we can eat it too. *(inventor of edible cupcake wrapper)*

Survey of Intrinsic Motivation

Part II of the survey focused on participants' intrinsic motivation for innovative activities. Intrinsic motivation is motivation that provides satisfaction from the task or activity itself, rather than in response to an externally provided incentive or reward. Intrinsic motivation is more likely to occur when people (1) find the task or activity interesting and engaging, (2) feel they have choice and autonomy, and (3) perceive they have the competence (knowledge, skills) to be successful (Deci and Ryan 1985).

To measure the young innovators' intrinsic motivation for inventing, twenty-one items (see Appendix A) were adapted from Deci and Ryan's Intrinsic Motivation Inventory (IMI) (Ryan, Koestner, and Deci 1999), a multidimensional validated instrument, consisting of seven subscales, and used to assess a person's intrinsic motivation and self-regulation related to a specific experience. The IMI, based on Deci and Ryan's Self-Determination Theory (SDT), is

"concerned with supporting our natural or intrinsic tendencies to behave in effective and healthy ways" (Self-Determination Theory n.d.).

For this research, twenty-one items were adapted from six of the seven subscales. (Relatedness, the seventh subscale, was not included in this study because there was no specific person or group within their schools with whom all children shared this experience and because the Relatedness subscale has not yet been fully validated.) The Interest/Enjoyment subscale is considered to be the most reliable self-report measure of intrinsic motivation, while the Perceived Choice and Perceived Competence scales are considered positive predictors of both self-report and behavioral types of intrinsic motivation measures. The Effort/Importance subscale is relevant to a person's motivation; the Value/Usefulness subscale is associated with self-regulation and internalizing of an experience, and the Pressure/Tension subscale is theoretically considered "a negative predictor of intrinsic motivation" (Self-Determination Theory n.d.).

The adapted IMI required participants to rate statements about their innovation process from "Very true" to "Not at all true." Items covered Interest/Enjoyment (six items), Perceived Choice (four items), Effort/Importance (four items), Pressure/Tension (two items), Perceived Competence (three items), and Value/Usefulness (two items). Four items were "reverse" items (e.g., "Inventing is boring."). An example of an item from each subscale is in table 2. (See Appendix B for full inventory.)

Table 2. Intrinsic motivation inventory subscales and examples of items used.

Subscale	Sample Item
Interest/Enjoyment	I enjoy inventing things very much.
Effort/Importance	It was important to me to do well at inventing.
Perceived Choice	It was my choice to participate in the invention program.
Value/Usefulness	I am satisfied with how I invent things.
Perceived Competence	I think I am pretty good at inventing.
Pressure/Tension	I often feel worried when I am inventing.

Only IMI subscale scores were totaled and averaged; percentages were rounded off; see table 3. Scores on the Interest/Enjoyment subscale, indicative of overall intrinsic motivation, were higher than on all other subscales: 89 percent (68 percent "very true" and 21 percent "usually true").

The scores were highly positive on all subscales, although there was an indication that some level of anxiety was experienced related to participation in the CIC (i.e., lower positive scores and higher negative scores on the Pressure/Tension subscale). That scale's lower scores broke down to 12 percent "usually not true" and 11 percent "not at all true"; the middle score "Sometimes true," not calculated within either positive or negative scores, was the highest of all subscale mid-scores (23 percent) for the Pressure/Tension subscale.

Table 3. Highest and lowest scores for each subscale.

Subscale (n=84)	% Very True/ Usually True	% Usually Not True/ Not at All True	% Sometimes True
Interest/Enjoyment	89%	2%	9%
Effort/Importance	88%	3%	9%
Perceived Choice	83%	11%	6%
Value/Usefulness	81%	5%	14%

Perceived Competence	85%	2%	13%
Pressure/Tension	54%	23%	23%

The higher level of low scores for Perceived Choice (11 percent) was largely due to one item related to participation in the invention program (required in some schools); other Perceived Choice items related to decisions on what to invent and were rated higher. It appears that many schools hold annual science or invention fairs and that participation in one or the other is often mandatory.

Interview Responses Related to Intrinsic Motivation

Pressure/Tension

Follow-up to the Pressure/Tension finding was included in the interviews. Participants were asked about their most difficult challenge while inventing and if they ever felt nervous or worried during the process. "Coming up with a workable idea" was the universal response when asked what presented the biggest challenge. Jonathan explained, "You have to go through a lot of ideas, make sure they are not copyrighted or invented already. Then you have to make sure they work good." All indicated that they were able to overcome their challenges, typically with help from a parent or teacher.

Some participants expressed nervousness during the innovation process. Brianna cited a lack of time, an observation that was immediately followed by self-blame for procrastinating. In Debbie's case her invention was being graded, and she expressed worry that if she didn't finish her invention on time, it would affect her grade. Jason said that someone continuously told him that his invention wouldn't work.

Debbie had quite a bit of anxiety about the convention, stating, "If we win, what if we don't know what to do and we don't know what to say?" Others worried about presenting in front of so many people; Annie compared it to stage fright, adding, "…it's really easy to overcome it once you start believing in yourself. That's all you have to do."

The children had a variety of methods for overcoming their nervousness. Brianna said, "I work on my invention really hard, and I practice what I'm going to say to the invention, like, at the invention convention…and I have other people question me. That sort of helps me feel better, because I know I will be able to answer any questions that are asked…" Jacob suggested, "I think maybe just ignoring what other people think. And just, invent whatever you want and use it yourself." Teddy's response was unique; he said "At the Invention Convention when I was a bit nervous, I assured myself before I got into that building with my invention, I assured myself, 'Okay, listen to me.' (I'm saying this to myself.) I said to, I said to myself, 'It's going to be okay. You know, if I lose, what the heck, that's, it's not, it's not a bad thing.'" But Debbie had the "sweetest" solution for overcoming nervousness, "Well I take a deep breath, and then I sometimes eat a little bit of candy…"

External Rewards

SDT maintains that if people receive tangible, gratuitous rewards for activities that are perceived as interesting and intrinsically motivating, people are less likely to participate in those activities in the future. This is particularly true for children (Deci, Koestner, and Ryan 1999). However, not all rewards are demotivating; for example, "performance-contingent rewards can convey

substantial positive competence information in cases where the person does well enough to get a level of reward that signifies excellent performance" (Deci, Koestner, and Ryan 1999, 629).

A question in Part III of the survey asked participants if they planned to keep inventing things even if they didn't win a competition or go to the invention convention. Of the 82 respondents to this question, the vast majority (75; 91 percent) said they did. Clearly, the motivation for their participation in innovation activities was strongly intrinsic, and since most of the awards (e.g., scholarships to invention seminars, support for patenting an invention) were distinctly tied to the inventing task, they served to contribute to positive motivation. Adam stated, "(Winning an award) doesn't matter. It's only having fun that matters."

Of the nineteen students interviewed, fifteen indicated they had received a prize or recognition for their inventions, allowing them to go to the statewide invention convention, where several won additional prizes including ribbons, a technology grant, a scholarship to inventing camp, a savings bond, and being named a "Recognized Inventor." Some prizes were awarded by companies (e.g., Northeast Utilities Foundation Energy Award, Stanley Black and Decker Award, ESPN Award). After receiving his award, Paul related that he felt proud and excited that his invention had been placed on display in the local science museum. Annie's award symbolized (to her) reaching her personal goal; she said, "It was just so amazing because in third grade…before I won that award, I was kind of upset because I didn't win an award. I won one at my school, but I didn't win one at the (state competition). So winning that award, I just accomplished my dreams because my goal that year was to get one of those prizes from the state invention convention. I was just so happy, and excited…" Gavin was philosophical as he commented on what the awards meant to him. "I wouldn't say I would've stopped inventing if I hadn't won an award, but I feel that the award really drove me to push my limits and try to go to new lengths and see what else I can accomplish."

Lack of External Rewards

In the case of interviewees who were not awarded a prize or recognition for their inventions, interviewers asked them if they felt disappointed. While Teddy said he felt "a bit down," most stated that they were just excited to be at the statewide competition. Brianna noted that, although her inventions hadn't won any awards, her work was "something I can be really proud of" and added "then I realized it's not all about winning, it's about having fun." Jason agreed, noting that he "felt really good" because he had worked hard and accomplished something. Jacob, the youngest interviewee, mentioned that he knew that there were a lot of people with good inventions and stated, "I was just thinking, 'Good for them.' I was okay with not getting a prize. I was just glad I was able to bring my invention in for people to look at."

Such responses demonstrate the intrinsic satisfaction that participation in innovation activities provides and further supports past research that indicates extrinsic rewards for intrinsically motivating tasks have little or no impact on motivation unless the rewards are directly related to the task and are tied to effort (Deci and Ryan 1985).

Participants' Additional Comments Related to Motivation

The survey ended with asking participants if there was something else they wished to tell us about their inventing experience. Fifty participants (60 percent) responded. Most responses reinforced how motivating these activities are and how motivated participants were to participate in them. Some examples are:

- I love being creative when I invent, and I want to keep inventing because I love to do it.
- The main reason why I love and do inventing is because it is challenging, which makes inventing fun.
- I had so much fun at the invention convention, my sister and I plan to go back next year on our own. (My school only does it in 5th grade.) I don't know what I'm going to invent yet, but I have lots of ideas.
- I love inventing things that will help people in many ways. This experience was a very good one. I loved the challenges in inventing and sharing my thoughts to people. I will never forget this wonderful experience.
- I am a two-year invention convention veteran, and this year I didn't get recognized, but I'm going to keep working. I still have a journal full of ideas ready to be used.
- For my flute mute invention I won a patent search award, and if possible, the application. I've gotten both and am now waiting for the patents to be issued by the U.S. Patent Office.

Research Question #2: What Are Students' Information Needs (Resources, Skills, Technologies) during the Innovation Process?

Survey of Information Needs—Overview

Part II of the survey focused on the information skills, resources, and technologies young innovators require to support the innovation process. These questions related to usefulness of specific information resources during the invention process. The first question listed fifteen resources (e.g., print, media, digital, libraries) and asked participants to rate how true it was that the resource was useful to them as they created their inventions.

Websites were the resource most heavily used by survey participants (75 percent), followed by public libraries (35 percent), databases (27.9 percent), and videos (22.1 percent). School libraries, YouTube, and books were also cited by about 18 percent each. All other resources were rated 13 percent and lower; see table 4.

Table 4. Six information resources most frequently used while creating inventions.

Resource (n=84)	Total % (n)	Very True % (n)	Usually True %(n)
Websites	75% (63)	45% (38)	30% (25)
Videos/YouTube	48% (39)	21% (17)	27% (22)
Public libraries	34% (28)	18% (15)	16% (13)
Databases	30% (25)	24% (20)	6% (5)
Books	20% (17)	12% (10)	8% (7)
School libraries	18% (15)	11% (9)	7% (6)

Interview Responses Related to Information Needs

In interviews all participants acknowledged they had access to the Internet and used the Web (particularly Google) as a resource during their inventing process. Debbie liked using websites to find the information she needed, explaining: "Websites help us because we don't need to go anywhere, like, outside of our house, and we can get the information that we need, and sometimes when we need; sometimes when we research at libraries, the libraries can be kind of far from our house, so the most convenient way is through Internet." Steven found that websites helped him come up with good ideas.

When asked why they thought websites were such valuable resources for supporting their invention activities, interviewees said websites "sparked ideas" and allowed them to search to see if their invention already existed or how they might make it better. Gavin thought websites helped him because "I don't have to go far to find what I need, so I can focus that time working on improving my invention and improving my problem." Brianna stated that when using the Web, she could "learn about stuff I don't learn in school." However, Brandon displayed a lack of understanding about how to evaluate the authority of the information he found on the Web, asserting, "Websites are all over the world, so you get every bit of information, and if you can't find your invention, you're pretty sure it's not out there."

Although there may have been confusion for some students who may have perceived an overlap between resources (e.g., books) and the facilities that house the resources (e.g., school libraries), the next question asked participants to similarly rate several human resources (e.g., parent, friend, librarian). Results indicate that parents were clearly the most important human resources, followed by teachers, friends, and other relatives (e.g., grandparent, sibling); see table 5. Librarians (like school libraries in the question above) were lowest of those rated, with just 5 percent of young innovators using them as a resource.

Table 5. Combined "Very True"/"Usually True" scores for human resources used while inventing.

Human Resource (n=84)	**Combined High Scores % (n)**
Father	75% (62)
Mother	73% (61)
Teacher	51% (42)
Friend or other kid (not a relative)	36% (30)
Grandparent	20% (16)
Brother/sister	16% (13)
Aunt/uncle/cousin/other relative	10% (9)
Librarian	5% (4)

Inquiry Skills

Importance of Skills

Part III of the survey focused on the importance of inquiry skills during the innovation process and on participants' perceptions of their own competence with inquiry skills. Participants were asked to rate a set of thirteen inquiry skills based on how important each skill was to the participants. Table 6 shows the highest ("very true"/"usually true") and lowest ("usually not true"/"not at all true") ratings demonstrating the importance participants placed on each skill.

Table 6. Highest and lowest ratings for importance of inquiry skills.

Importance Item (n=82)	**Very true/ Usually true % (n)**	**Usually not true/ not at all true % (n)**
Asking good questions	88% (72)	4% (3)
Revising your questions so they do a better job of asking what you need to know	69% (55)	13% (10)
Knowing where to go to find answers to your questions	77% (63)	9% (7)
Using what you already know to figure out answers to your questions	82% (63)	4% (3)
Using different resources, such as books and the Internet, to answer your questions	60% (48)	12% (10)
Finding needed information	87% (71)	5% (4)
Taking good notes	72% (59)	12% (10)
Using different kinds of print and online resources to find the information you need	57% (46)	19% (15%)
Evaluating the information you found in the resources you used	65% (53)	16% (13)
Finding the best information to answer your questions	83% (67)	6% (5)
Comparing different ideas	81% (66)	5% (4)
Choosing the best idea	90% (74)	1% (1)
Thinking about what you could do better the next time you invent something	83% (67)	9% (7)

Perceptions of Proficiency with Skills

The same thirteen items were repeated in the survey, but this time participants were asked to rate how good (proficient or competent) they are at performing each of these tasks without help. At this point in the survey, there was a significant decline in participation from the previous question (from eighty-two to fifty-five respondents or below). Ratings ranged from "very good at it" to "not at all good at it." Table 7 indicates that the fifty-five respondents rated themselves highest in "Thinking about what you could do better the next time you invent something" (60 percent), "Using what you already know to figure out answers to your questions" (56 percent) and "Choosing the best idea" (56 percent).

While only small numbers of respondents rated themselves in the lowest category ("Not at all good at it"), for the next category ("somewhat good at it") respondents clearly recognized they had room for improvement, particularly in these skills: "Revising your questions so they do a better job of asking what you need to know" (26 percent), "Using different kinds of print and

online resources to find the information you need" (22 percent), "Evaluating the information you found in the resources you used" (21 percent), and "Taking good notes" (21 percent).

Prior research has revealed that children's perceptions of their information literacy skills competence are significantly correlated with their actual competence as measured by a validated test of information literacy (Arnone and Reynolds 2009), and clearly more than one in five of these successful innovators had some doubts about the strength of their skills in some areas.

Table 7. Participants' self-ratings for competence on inquiry skills.

Item (n=55)	**Very good at it % (n)**	**Good at it % (n)**	**Somewhat good at it % (n)**	**Not at all good at it % (n)**
Asking good questions	47% (26)	37% (20)	12% (7)	4% (2)
Revising your questions so they do a better job of asking what you need to know	22% (12)	46% (25)	26% (14)	6% (3)
Knowing where to go to find answers to your questions	39% (22)	42% (22)	17% (10)	2% (1)
Using what you already know to figure out answers to your questions	56% (31)	38% (20)	3% (2)	1% (1)
Using different resources, such as books and the Internet, to answer your questions	49% (27)	37% (20)	14% (8)	0% (0)
Finding needed information	50% (28)	39% (22)	11% (6)	0% (0)
Taking good	35% (18)	39% (20)	21% (12)	5% (3)

notes				
Using different kinds of print and online resources to find the information you need	23% (13)	51% (28)	22% (12)	4% (2)
Evaluating the information you found in the resources you used	29% (16)	46% (26)	21% (11)	4% (2)
Finding the best information to answer your questions				
Comparing different ideas	45% (25)	43% (23)	10% (6)	3% (1)
Choosing the best idea	56% (30)	33% (18)	9% (5)	2% (1)
Thinking about what you could do better the next time you invent something	60% (33)	27% (15)	13% (7)	0% (0)

Evaluating Quality of Web Sources

A follow-up question during the phone interviews was used to dig more deeply into how participants actually performed such inquiry skills, specifically, evaluating the quality of Web sources. Some participants said that at times adults help them verify the quality of the resources they were using. For example, Sabrina's dad helps her by evaluating a source for reliability and appropriateness before she's allowed to use it. Jonathan and Brandon said they look at other sources to see if the information is consistent across sources. Jacob decides it is a good source if he has used the website before and found the things he found there worked. If he hasn't used it before, he checks other websites or other reliable resources to see if they say the same thing. If more than one does, he considers the new site a reliable source. Jason checks both other websites and books to verify the information. Adam evaluates websites by looking at what's written at the bottom "to see if the description is very short and might look kind of fake to see if maybe it might send a virus."Brianna responded, "Well, you have to find out if it's a reliable source. You

don't want to take Wikianswers or Yahoo answers or anything like that because they are just random people submitting replies. You can't really trust them. But, you can trust sites more like Wikipedia and stuff like that because those are more reliable sites." Christopher also uses Wikipedia, explaining "(s)ometimes I use [Wikipedia] and because I usually can trust [it] because it's made by people who just do that for a job, so I think that's a good way to do it."

These responses indicate students were indeed evaluating the sites they used but were unaware that they were using faulty criteria for doing so. Jason stated, "[S]ometimes I will look at who wrote the article or whatever I'm reading online. I'll look and see if they are a doctor, or someone who works in that subject area. Sometimes I can tell by the style of writing, and see if they used proper grammar and things such as that. To see if it's written by just a regular person or someone on a website and are just answering something and don't care to use proper grammar and things." Annie says she knows she is good at evaluating websites because she has been using computers for a really long time and knows how to skim content when she first looks at the site. She explains, "Because what I do is I skim through it, and look at what's happening. I mean, what's it giving you and what it's asking you to do and if it seems safe then it's good. And if it's not, you shouldn't use it. That's what I do." While these young innovators believe they know how to evaluate the information and information resources they use, their responses indicate that their evaluation methods and their perceptions of methods' effectiveness are flawed.

Only Debbie credits her school librarian for teaching her to evaluate Web resources. "Well, in our school, our library, our librarian, always tells us not to use Wikipedia, so we generally stay away from Wikipedia. And then if we're on a website one thing [we] would look for is the author, the dates, and if …the website actually ends with .com or .edu or .gov or something. So if we know if it has an author, the date it was published, and ends in .edu or .gov, we would normally think that that's a good website…"

If the majority of these successful young innovators have developed poor inquiry skills, it is likely to be an even bigger problem for those who do not participate in such activities. Clearly, this is an area in which inquiry skills instruction, taught in the context of the STEM innovation learning challenge, will be of benefit to all students who wish to participate.

Research Question #3: What Roles Do Teachers and Librarians Play in Supporting and Facilitating Student Innovation?

Teachers

When asked on the survey to rate the usefulness of a variety of human resources, 51 percent of respondents stated their teachers had an important role to play, although teachers did not give young inventors their ideas or help them make their inventions, teachers did lead invention competitions in their schools, act as point of contact for school invention fairs, and work with students to prepare them for the state competition.

In the follow-up phone interviews, participants made it clear that their teachers did help facilitate their progress (e.g., through brainstorming and helping clarify ideas). When asked if she could think of other ways in which teachers could help, Debbie said. "[T]he way the teacher could help is…organizing something like a school field trip…to a museum, and then just organize an activity in the class thinking about all the problems that happen to them in the day and how they could solve the problem, and I think that would be a good way to find projects they could do it on…" Several participants suggested ways teachers could help that may actually be more

appropriate for their school librarians: e.g., "provide more information about the inventing process," "help find good sources of information," "identify reliable sources and trustworthy websites."

Librarians

Only 5 percent of survey respondents acknowledged a librarian as an important human resource; see table 5. Ten telephone interviewees stated they did not use a library at all, and for those that did use a library, most used it to find books with information about their inventions.

When asked why they did not use their school library, the most common answers were that it didn't have any relevant books or that computers were preferred. These young innovators appear to perceive libraries as book repositories and computers as more efficient, faster, and more convenient alternative sources of quality information. Jonathan commented, "Most websites can have just as good information as books. And I have easy access to online services, and I figured it would just be much easier for me."

When asked for ideas on how their librarians might be able to help them in the future, Christopher responded, "They might be able to, if you ask for a topic or maybe you can ask about the topic of a book and see if they have any books on that." Sabrina agreed, saying "Because the libraries have a lot of books in them but none of them are really about the inventing process or anything in the ones in my school and the public library so they're not really helpful." Cathy said that beyond finding books, librarians could help her "think of ideas and help [me] understand the concept of something." Gavin stated, "I would use the library if they had a section on what I was looking for, but a lot of the times they don't."

When asked for ways a librarian might have a role to play in helping them through the innovation process, Gavin said, "Like it [is] their job to be friendly to people and to help them find what they need and use the information to do what they want to achieve their goals." Debbie stated, "I think … a librarian could help us most through researching, because they know more about which websites are more reliable, and they also, if you're having problems with where to find a problem, the librarian can help you look through all the sources that you need." Brianna stated that her school librarian did help her by finding some good sources and printing out the information she needed.

Research Question #4: Is There a Relationship between Participation in Innovation Activities and Interest in STEM Learning?

Innovation experiences can influence STEM-related learning and career goals. Ten interviewees evidenced interest in STEM-related learning when they mentioned an interest in a career as a scientist, engineer, or computer scientist; three would like to be inventors. Annie plans to be either a vet or a marine biologist, Gavin a biomedical engineer, and Debbie an astronomer. Although Brandon already knew he wanted to be a lawyer, he discovered the specialty area of patent law during his innovation experience. He explained why it attracted him, "Patent law is pretty interesting with patent infringement it's mostly contracts and stuff, and designs and stuff. If you don't have a proper design down, then someone may be able to modify it." Rosemary also expressed interested in pursuing a legal career. Teddy wants to be either a history teacher or a physicist; Rebecca wants to be an actor or, like Cathy, a scientist or science teacher. Steven stated he wants to be a professional baseball player, and Adam isn't sure what he wants to be.

Implications

For these creative students, the benefits of participating in innovation activities goes far beyond established learning standards, outcomes, and products. Participation in innovation activities in the library will stimulate their curiosity, stretch their imaginations, and motivate their passion for solving authentic problems that help real people, teach them to be persistent and open-minded, and encourage both emergent and divergent thinking.

School librarians must help all students develop strong inquiry skills. School librarians must also help change these young innovators' outdated perceptions of libraries as book repositories so learners can, instead, see libraries as innovation spaces where ideas are valued and creativity flourishes. In the process, young innovators' perceptions of librarians' roles would change from gatekeepers to "innovation mentors."

Transforming School Libraries into Innovation Spaces

In a literature review E. C. Martins and F. Terblanche (2003) sought to identify the factors in an organizational culture that influence the stimulation of creativity and innovation. They found these determinants:

- structure (promotion of autonomy, flexibility, and collaboration as opposed to rigidity, control, and predictability),
- an innovative overall strategy (e.g., as part of the school's or library's vision),
- support mechanisms (e.g., recognition and rewards, availability of resources such as time, information, technology, and other creative people),
- behavior that encourages innovation (e.g., generation of new ideas, tolerance for mistakes), and
- open communication (transparent, based on trust).

All of these determinants can and should be found in school libraries. School librarians have opportunities to create exciting innovation spaces within their libraries and to mentor innovative thinking in their students. School librarians are less constrained than are other educators by the rigid curricula, standards, and tests found in many of today's classrooms. In addition, school librarians have opportunities to collaborate with a variety of education professionals. School librarians often see their role as have an impact on all children, opening up their minds to not only what is but also what can be. As a result, school librarians can use library spaces to stimulate students' curiosity and inquiry and to encourage and support learning autonomy, creativity, and feelings of competence and empowerment.

One way to achieve these goals is by establishing a section of the library as an "innovation space" that contains books, computer programs, games, and other resources (e.g., 3-D printers with CAD software) to motivate and support innovative thinking. The innovation space can be enhanced by posting thought-provoking questions that are changed frequently and could be suggested by students. Also helpful would be videos showing young innovators.

Alternatively, the entire school library can be considered an "innovation space" with stations set up in various areas to lead students through various activities in which they learn what is required to be innovative, how to go successfully through the process, and ways in which they can communicate with other young and adult innovators. Ideally, the innovation space also

provides access to activities that teach kids idea-generation strategies such as brainstorming and mind mapping.

These changes may have implications for collection development and how school librarians market their library's services, programs, and resources. For example, school librarians could add books about well-known adult and young innovators, books (such as Michael Gelb and Sarah M. Caldicott's *Innovate Like Edison* and Judith St. George and David Small's *So You Want to Be an Inventor*?) and, for educators and for students, videos about innovation. On the library's website, the school librarian could add links to relevant websites. Newly developed programs and services that motivate and support young innovators should be marketed to administrators, classroom teachers, and parents. These programs could also be used as opportunities for collaboration between school librarians and classroom teachers, particularly in the STEM subjects.

Transforming School Librarians as Innovation Mentors

Research has demonstrated that creative youngsters often cannot depend on their classroom teachers to stimulate and support their creative ideas; rather, teachers often express disapproval and even dislike of such students (Cropley and Cropley 2013). Innovation can be a lonely process, strewn with a range of barriers and hurdles. Tony Wagner (2012) found that young innovators from both affluent and high-needs schools need mentors to encourage their passions. For every child who is encouraged to think creatively and participate in innovation activities and who is guided and supported along the way, there are many more with exciting and valuable ideas who do not receive this type of mentoring.

To establish a mentoring relationship between school librarian and student, it is essential that both partners be actively engaged in the relationship, that a high level of trust exists between the mentor and the mentee, and that the mentor sees himself or herself as a facilitator within a supportive learning climate (Zachary 2012).

Conclusion

In school libraries that serve a central role as both a physical and emotional space in which students' imaginations, creativity, and sense of wonder are nourished and expanded, school librarians are the ones who can serve as role models and mentors to help students to (1) feel comfortable and free to ask divergent (and sometimes outrageous) questions, (2) gain skills needed to seek authentic answers to those questions in a variety of credible, accessible sources, (3) deeply explore innovative solutions to the problems that interest and perplex them, and (4) persist in pursuing ideas that will ultimately change our world.

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Appendix A: Young Innovators Online Survey

Hello. My name is Dr. Ruth Small and I am from the School of Information Studies, at Syracuse University. I am asking you to participate in this research study because you are a student in 4th-8th grade who has participated in invention activities during the 2012–2013 school year.

PURPOSE: A research study is a way to learn more about people. In this study, I am trying to learn more about your inventing experiences this year and your ideas and opinions about the process of inventing.

PARTICIPATION: If you decide you want to be part of this study, you will be asked to answer the questions in this online survey that ask you how you felt about participating in invention activities. It will take you about 15–20 minutes to answer these questions, and all questions must be answered in one sitting, and you must press DONE when you are finished. You are also asked if you will take part in a telephone interview two weeks after the survey.

RISKS & BENEFITS: There are some things about this study you should know. You may feel a little nervous about participating. Most children who take part in this study will benefit. A benefit means that something good happens to you. We think these benefits might be that you will enjoy sharing your ideas and helping us know how to better help other kids with their inventing activities.

REPORTS: When I am finished with this study I will write a report about what was learned. This report will not include your name or that you were in the study. This is to protect your privacy.

VOLUNTARY: Voluntary means that you do not have to be in this study if you do not want to be. I have already asked your parents if it is ok for me to ask you to take part in this study. Even though your parents said I could ask you, you still get to decide if you want to be in this research study. You can also talk with your parents, grandparents, and teachers before deciding whether or not to take part. No one will be mad at you or upset if you decide not to do this study. If you decide to stop after we begin, that's okay too. You can also skip any of the questions you do not want to answer.

QUESTIONS: You can ask questions now or whenever you wish. If you want to, you may call me at 315-443-6144. If you are not happy about this study and would like to speak to someone other than me, you or your parents may call the Syracuse University Institutional Review Board (IRB) at 315-443-3013.

If you agree to participate in this survey, you should type your name below and click on the **YES** button and continue answering the questions. If you do not wish to participate, click on the **NO** button and you will exit this survey. Be sure to print a copy of this page for yourself.

TYPE YOUR NAME BELOW:

Do you wish to participate in this survey (click on the circle in front of your answer)?

- YES, I want to participate in this study.

- NO, I do not want to participate in this study.

Would you be willing to be interviewed by phone within the next few weeks?

- Yes
- No

Do you wish to participate in this survey (click on the circle in front of your answer)?

- YES, I want to participate in this study.
- NO, I do not want to participate in this study.

Would you be willing to be interviewed by phone within the next few weeks?

- Yes
- No

Do you wish to participate in this survey (click on the circle in front of your answer)?

- YES, I want to participate in this study.
- NO, I do not want to participate in this study.

Would you be willing to be interviewed by phone within the next few weeks?

- Yes
- No

PART I

Dear Young Innovator,

Thank you for participating in this survey to learn how kids go about inventing things. There are three parts to this survey. Please be sure to answer every question to the best of your ability.

DIRECTIONS: This part asks some questions about you and about your invention.

What is the grade level that you are in now (click on the circle in front of your answer)?

- Grade 4
- Grade 5
- Grade 6
- Grade 7
- Grade 8

Are you a boy or girl?

- boy
- girl

What is the name of your school?

In what town or city and state do you live?

Please describe in the box below the invention you created.

Why did you create this invention? (type your answer into the box below)

PART II

Directions: The following questions ask you to think about how you felt as you were creating your most recent invention. Please read each sentence carefully. Then, click inside the circle that best says how true the sentence is for you.

	Not at all true	Usually not true	Sometimes true	Usually true	Very true
I enjoy inventing things very much.					
I created an invention because I wanted to.					
Inventing was fun to do.					
I often feel worried when I am inventing.					

It was important to me to do well at inventing.

The invention activities were interesting and enjoyable.

I would describe inventing as fun.

I think I am pretty good at inventing.

I felt like it was not my own choice to create an invention.

I made my own decisions about what to invent.

I am satisfied with how I invent things.

The more difficult the problem, the more I enjoy trying to solve it.

Inventing is boring.

I put a lot of effort into inventing.

It was my choice to participate in the invention program.

After working at creating my invention for a while, I felt pretty capable of being successful.

I feel confident in my ability to create an invention.

I didn't try very hard to do well at inventing.

I think inventing was an important activity for me.

I did not feel nervous at all about participating in the invention program.

I would like to participate in future invention programs because I enjoyed my experience.

PART III

Directions: The next set of questions asks you about some of the things and then some of the people you may have gone to for help when creating your invention.

As you were inventing, you may have needed to find information to help you. Below is a list of resources or technologies you might have used to find information as you were thinking of an idea for your invention or as you were creating your invention.

Below is a list of resources that inventors sometimes use while creating their invention. After each resource, choose the response that describes **how true** it was that the resource was useful to you while you were creating your invention.

	Not at all true	***Usually not true***	***Sometimes true***	***Usually true***	***Very true***
books	Not at all true	Usually not true	Sometimes true	Usually true	Very true
Web sites	Not at all true	Usually not true	Sometimes true	Usually true	Very true
magazines	Not at	Usually not	Sometimes	Usually	Very

	all true	true	true	true	true
databases	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
your school library	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
email	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
blogs	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
wikis	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
videos	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
e-books	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
podcasting	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
Twitter	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
Facebook	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
YouTube	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true
a public library	☐ Not at all true	☐ Usually not true	☐ Sometimes true	☐ Usually true	☐ Very true

If there was another type of resource not listed above (other than people) that was useful to you while you were creating your invention, please type it in the text box below.

Directions: Sometimes inventors ask people for help before and as they create their inventions. Below is a list of people you might have asked for guidance, help or information when you were beginning to think about your idea or as you were creating your invention.

After each type of person, choose the response that describes how true it was that the person was helpful to you before and during the time you were creating your invention by clicking in the appropriate circle.

	Not at all true	***Usually not true***	***Sometimes true***	***Usually true***	***Very true***
your mother					
your father					
a grandparent					
a brother or sister					
another relative					
a friend					
a teacher					
a librarian					
an adult inventor					

Other (please tell us what by typing in the box below).

You are almost done! Just one more page to go. Click on the "Next" button to finish the survey.

Directions: Below are some activities you may have done while thinking of your invention idea or creating your invention.

Choose how true it is that each activity below was important to you while you were inventing by clicking on the circle under your answer.

	Not at all true	*Usually not true*	*Sometimes true*	*Usually true*	*Very true*
asking good questions					
revising your questions so they do a better job of asking what you need to know					
knowing where to go to find answers to your questions					
using what you already know to figure out answers to your questions					
using different resources, such as books and the Internet, to answer your questions					
finding needed information					
taking good notes					
using different kinds of print and online resources to find the information you need					
evaluating the information you found in the resources you used					
finding the best information to answer your questions					
comparing different ideas					

Other (please tell us what)

How good you are at doing each the following tasks without help?

	not at all good at it	***somewhat good at it***	***good at it***	***very good at it***
Asking good questions.				
Revising your questions so they do a better job of asking what you need to know.				
Knowing where to go to find answers to your questions.				
Using what you already know to figure out answers to your questions.				
Using different resources, such as books and the Internet, to answer your questions.				
Finding needed information.				
Taking good notes.				
Using different kinds of print and online resources to find the				

	not at all good at it	*somewhat good at it*	*good at it*	*very good at it*
information you need.				
Evaluating the information you found in the resources you used.				
Finding the best information to answer your questions.				
Comparing different ideas.				
Choosing the best idea.				
Thinking about what you could do better the next time you invent something.				

Other (please specify)

Do you plan to keep inventing things even if you don't compete or win awards? (Click on the circle in front of your answer.)

- YES
- NO

If there is something else you would like to tell us about your inventing experiences, type it in the box below.

Thank you so much for participating in this survey. Your answers will help us learn how to provide better support for young inventors like yourself.

Appendix B: Young Innovators Intrinsic Motivation Inventory

Young Innovators Survey Part II:

Intrinsic Motivation Subscale

(Twenty-one items adapted from Deci and Ryan's Intrinsic Motivation Inventory)

Directions: The following directions were in Part II of the survey:

> **Directions:** The following questions ask you to think about how you felt as you were creating your most recent invention. Please read each sentence carefully. Then, click inside the circle that best says how true the sentence is for you.

Response choices: The following responses were available to participants:

Not at all true; Usually not true; Sometimes true; Usually true; Very true

Aspects of motivation: In the list below, the parenthetical information identifies the aspects of motivation surveyed. This aspect information was not displayed in the survey as viewed by participants. The "R" in square brackets identifies a reverse item.

Intrinsic motivation subscale:

I enjoy inventing things very much. (Interest/Enjoyment)

I created an invention because I wanted to. (Perceived Choice)

Inventing was fun to do. (Interest/Enjoyment)

I often feel worried when I am inventing. **[R]** (Pressure/Tension)

It was important to me to do well at inventing. (Effort/Importance)

The invention activities were interesting and enjoyable. (Interest/Enjoyment)

I would describe inventing as fun. (Interest/Enjoyment)

I think I am pretty good at inventing. (Perceived Competence)

I felt like it was not my own choice to create an invention. **[R]** (Perceived Choice)

I made my own decisions about what to invent. (Perceived Choice)

I am satisfied with how I invent things. (Value/Usefulness)

The more difficult the problem, the more I enjoy trying to solve it. (Value/Usefulness)

Inventing is boring. **[R]** (Interest/Enjoyment)

I put a lot of effort into inventing. (Effort/Importance)

It was my choice to participate in the invention program. (Perceived Choice)

After working at creating my invention for a while, I felt pretty capable of being successful. (Perceived Competence)

I feel confident in my ability to create an invention. (Perceived Competence)

I didn't try very hard to do well at inventing. **[R]** (Effort/Importance)

I think inventing was an important activity for me. (Effort/Importance)

I did not feel nervous at all about participating in the invention program. (Pressure/Tension)

I would like to participate in future invention programs because I enjoyed my experience. (Interest/Enjoyment)

Appendix C: Young Innovators' Interview Questions

1. How did you get involved with inventing things?
2. Everyone who took our survey agreed that inventing is fun. What makes inventing fun for you?
3. What do you think is the most difficult thing about inventing? How did you overcome it?
4. Have you ever been awarded a prize or received recognition for inventing something? How did that make you feel?
5. On the survey, many kids said that websites were their most useful resource. From where did you access the internet? In what ways do websites help you?
6. Every kid who responded to the survey said they were either good or very good at evaluating information they found in the resources used while inventing. How do you evaluate information or the places you find information? In other words, how do you decide if it's good information, or a reliable source, or if it's something you maybe shouldn't use? How do you know that you are good at evaluating information?
7. Some kids said that participating in inventing activities sometimes made them feel nervous or worried. Do you ever feel this way when you're inventing? What do you think causes these feelings?
8. Did your teacher help you at all when you were inventing?
9. Did you use your school library or public library to help you during the invention process? Can you think of a way in which a librarian might be able to help you in the future?
10. What do you want to do when you grow up?
11. How do you think your inventing experiences might be useful to you when you become an adult?
12. If you could give advice to other kids who might want to try to invent things, what would it be?

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