Evaluation of *Sparticl*
STEM Website for Teens

Abbreviated Version of Report
Prepared for Twin Cities Public Television
by Barbara N. Flagg, Ed.D., Director

with assistance of
Alice Bernard, Laura Minningerode, Matt Loth
and
Abby Goodlaxson, Hilde Hochwald, Debra Klich, Patricia Sullivan-Hall

Condensed Version of Report No. 14-002
March 25, 2014
TABLE OF CONTENTS

EXECUTIVE SUMMARY 3
INTRODUCTION 5
METHOD 5
RESULTS 8
   USE OF SPARTICL CONTENT AND FEATURES 4
   ENGAGEMENT WITH SPARTICL 11
   VALUE OF SPARTICL 13
SHARING SPARTICL EXPERIENCES 16
AWARENESS OF SPARTICL SPONSOR 17
IMPACT ON INTEREST IN STEM JOBS OR CAREERS 18
IMPACT ON LEARNING 19
IMPACT ON SCIENCE CURIOSITY 23
IMPACT ON VALUE OF SCIENCE 25
DISCUSSION 27
Produced by Twin Cities Public Television, St. Paul, MN, and supported by 3M, Sparticl is a free web and mobile service intended for teens but open to all. For Sparticl, experts have curated existing web videos, games, articles and activities to provide a digital library representing the very best in science, technology, engineering and math education.

For the evaluation of Sparticl, Multimedia Research recruited 64 eighth graders from six states to explore Sparticl for a minimum of two hours. Teens experienced a broad expanse of what website has to offer, a wide range of content categories and resource media types.

**Teens enjoy exploring Sparticl** because of the range of information available, the ease of use and the variety of learning formats, particularly the game format. However, they raised concerns about inoperable and/or slow external sites, issues of usability, and the limited range of topics. Four of ten teens described earning points as a motivational reward, and two of ten considered points to be fun or interesting; yet two of ten participants felt that they did not understand the purpose of points.

**Teens value Sparticl.** A majority of teens reported that they will return to the website either for help with a school project or topic or because the site provides interesting information. Most users, particularly the girls, were likely to recommend Sparticl to others. Teens valued Sparticl because it has pulled together the best STEM websites in one place, but some users also found the keyword search routine and limited resources to be a disadvantage.

**Teens share Sparticl with others.** Two-thirds of teens told friends or teachers about the site; and eight out of ten teens shared memorable Sparticl content with family and friends.
**Sparticl increases teens’ awareness of 3M.** Experiencing the website led teens to conclude that 3M cares a lot about helping youth learn about science and science careers, and half of the participants recognized that 3M had made Sparticl possible.

**Sparticl increases interest in and awareness of STEM careers.** One-quarter of our teens increased their interest in STEM jobs or careers. Two-thirds of participants reported learning from Sparticl about STEM jobs or careers. Exposure to the website also raised teens’ awareness of the wide range of STEM fields and raised awareness of specific jobs within fields.

**Teens learn from Sparticl.** All teens recalled content from at least one of the main Sparticl content categories, and half of the teens recalled at least one fact or described at least one cause, relationship or process from their Sparticl exploration. Number of resources explored related to higher recall in each category, and the resources of Earth & Space and Body & Brain were the most memorable. Girls were significantly more likely than boys to recall specifics from the categories of Body & Brain and Living Things. Additionally, using Sparticl broadened teens’ definition of science to include the concept that science is important.

**Sparticl sparks teens’ curiosity.** Exposure to Sparticl resources increased the specificity of topics teens were curious about and increased their interest in topics. Half of the teens reported that their curiosities were sparked by something on Sparticl and that they would go to the website for answers to their questions.

**Sparticl changes how teens value science.** After exposure to Sparticl, teens significantly increased their valuation of the importance of knowing and studying science and the utility of science in solving everyday problems. When asked for an example of how science, technology or engineering is valuable to society, four out of ten teens specifically referenced a Sparticl resource.
Produced by Twin Cities Public Television, St. Paul, MN, and supported by 3M, Sparticl is a free web and mobile service intended for teens but open to all. For Sparticl, experts have curated existing web videos, games, articles and activities to provide a digital library representing the very best in science, technology, engineering and math (STEM) education. The design of Sparticl is similar to a STEM magazine, news show or encyclopedia in that users can explore through a variety of media their own familiar interests as well as be exposed serendipitously to unfamiliar content and experiences. One of the goals of Sparticl is to simplify searching for high quality content, as teens can be overwhelmed by the results on commercial search engines. Teens can also participate in the Sparticl community by answering quiz questions, ranking content, sharing it, and recommending new content, while earning points and badges.

Multimedia Research, an independent evaluation group, implemented an evaluation of Sparticl in the winter of 2014. In addition to assessing Sparticl’s usage, engagement, and value with 64 teens, the pre-post study focused on impact of exposure to Sparticl on (1) awareness of STEM jobs or careers; (2) content learning; (3) definition of what science is; (4) science curiosity; (5) the value of science; and (6) awareness of Sparticl’s sponsor.

Sample

Sixty-four (N = 64) 8th grade boys and girls were recruited around six national sites, including Miami, FL; Baltimore, MD; Boston, MA; Milwaukee, WI; St. Louis, MO; and Austin, TX. Two-thirds (67%) of the sample were 13 years old and one-third (33%) were 14 years old. Minorities comprised 23% of the sample.

Internet activity levels. Evenly distributed across the sites, the 32 boys and 32 girls had access at home to a computer that they could use with a fast (not dialup) Internet connection to go online to Sparticl. The recruitment criteria required experience using the Internet: 53% of the sample reported spending 5-10 hours on the Internet during a typical week and 47% reported spending more than 10 hours.

---

1 See http://www.sparticl.org/AboutSparticl/ for a video tour of the features of the site.
2 Additional quotes from participants and more detailed analysis are not included in this condensed report. For the complete report, please contact info@sparticl.org.
Of a list of Internet activities that our participants reported doing at least three times a week,
- 100% played games on a website
- 88% watched short videos (for example, Youtube, Vimeo)
- 80% used a social media site (for example, Facebook, Twitter, Instagram, MySpace)
- 78% visited informational websites for school
- 56% visited informational websites for their own interest
Those who reported using a social media site were also significantly more likely to report more
hours per week on the Internet.\(^3\)

**STEM interest levels.** To generalize to teens who are potential users of *Sparticl*, participation in
the evaluation required that the teen participants be at least “a little” interested in STEM. The
64 teens rated how much they enjoyed science, technology or engineering outside of school as
“very much” (20%), “somewhat” (55%) or “a little” (25%).

**Procedure**

Participating teens were asked to explore *Sparticl* for a minimum of two hours within a two-
week period and were provided with extra incentive to explore for a third hour. In reviewing
data of registered Sparticl users over three two-week periods following the launch of *Sparticl* in
October, 2013, the maximum cumulated time-on-site ranged from 1.7 to 2.1 hours, so a two-
hour “treatment” within a two week period is within the bounds of natural usage.

Teens who express some STEM interest, as described in the Sample section above, have
intrinsic motivation to use a website such as *Sparticl*, but to participate in this time-limited
evaluation, participants received extrinsic motivation in the form of a $100 honorarium for
completing two hours of exploration or $150 for completing three hours within a two-week
period. Almost all (92%) participants explored *Sparticl* for three hours or more, and 8%
completed two hours but less than three hours within their two weeks.

Evaluation methods included self-administered online pre and post surveys and pre and post
interviews by phone. Upon collection of parent and teen signed consent forms, field
researchers emailed participants a URL at which teens answered a 10-minute pre-survey. The
pre-survey asked questions about their Internet usage; science curiosity; value of science;
interest in STEM jobs or careers; and awareness of company involvement in science education.

---

\(^3\) Fisher Exact Probability Test is used to test whether two categorical variables differ significantly in the proportion
with which they fall into two classifications. \(p = 0.01\), two-tailed Fisher’s exact test.
After the pre-survey completion, researchers interviewed participants by phone. The brief interview asked participants to explain what science is and to give an example of how science, technology or engineering is valuable to society. Additionally, participants described STEM topics in which they were interested and these topics were suggested as starting points in their exploration of the Sparticl website.

After the phone interview, researchers emailed participants the Sparticl website URL, their individual login information, and a request to begin their exploration of Sparticl by looking for the topics described in their phone pre-interview. The email listed topics specific to each teen. Sparticl can be browsed by visitors of any age; however, the interactive community features of ranking, commenting on, and sharing content are available only to registered users. All participants were pre-registered to give them the ability to use these features.

During the two-week exploration period, researchers periodically reminded and encouraged teens to use Sparticl if event logs showed infrequent visits or duration. Upon completion of the two weeks, participants completed an online survey that asked the same questions as the presurvey. A follow-up phone interview queried users about the appeal and value of Sparticl and what they learned from their online experience as well as repeating the pre-interview questions.

**Data Analyses**

Quantitative data from surveys are presented as frequencies in text and charts, and appropriate statistical tests were implemented for all quantitative data, looking at relationships with the demographic and background variables reported in the above Sample description. In this report, footnotes present a definition of a statistic when first used and also present the statistical test results. A statistical test that gives a p-value, or probability value, lower than .05 is reported as “statistically significant.” **This means that a difference between groups is noted as significant only if it has a 5% or smaller likelihood of occurring by coincidence or chance.**
From now on I’ll definitely go on there and look for anything I need to research because it’s harder to go out on like Google, for instance, and choose. You have all these options and thousands and thousands of hits for each category, but it is hard to determine which ones are good. And so Sparticl provides really detailed and specific information...

...13 year old White Female, after using Sparticl

Use of specific Sparticl features varied widely over the two week period. Our 64 teens earned 18 to 359 points, activated 0 to 118 questions, and viewed 5 to 109 unique resources. Few teens rated or commented on a resource. Most participants explored resources from all of Sparticl’s content categories, with text, video, game and interactive appearing as the resource types most frequently seen.

Time spent exploring Sparticl. After the two week usage window, 92% of participants (with parent confirmation) reported that they explored Sparticl for three hours or more, and 8% completed two hours or more use. Those who used the site for the higher total time did not differ with respect to demographic or background variables compared with those who used Sparticl for less time.

Sparticl point acquisition. Point acquisition is also a variable by which we can measure site usage and engagement. Sparticl’s current point system rewards registration, activating content questions, answering questions correctly, viewing a variety of resource sites, inviting a new user, and participating in the Sparticl community around a resource by liking, disliking, commenting, sharing, and recommending.

Points acquired. In their use of Sparticl, the teens earned 18 to 359 points, with half of the participants earning below 54 points and half earning above this median score. The chart shows a skewed point distribution, with one outlier at 359 points from a teen who tried hard to reach the list of high point scorers.
Questions activated. Almost all of the points that users earned are accounted for by correctly answering questions. A majority of users (70%) activated questions. The second chart shows the skewed distribution of the number of activated questions, with a median of 7 questions and our same participant outlier at 118 questions.

Correct answers ranged from 20% to 100% correct, with an average 50% correct. The higher the number of correct answers, the higher the point total overall ($r = .91$). Correct answers contribute to 83% of the variance in the point totals, and number of resources viewed contributes an additional 7% to the point total variance.

Resource usage. In their two week usage period, teens viewed 5 to 109 unique resources, for more than 30 seconds. The top chart displays a bimodal distribution with a median viewing of 26 resources and an outlier at 109 resources.

Rating, commenting, inviting, sharing activity. Of the teens, 16% rated a resource and 9% commented on a resource. Our highest scorer, at 359 points, was the only participant to invite a friend to Sparticl and make a resource recommendation, garnering higher points for such activities. No participant shared a resource during the two week period.

Exploration of Different Types of Content. In order to motivate teens to explore Sparticl initially, participants were asked to describe two areas of science that interested them, and then they were directed to start their exploration on the site in those areas.

---

4 The Pearson Product-Moment correlation coefficient, $r$, describes how well two variables are related, in this case number of points and number of correct answers. $r$ ranges from 0 to 1.
The main areas of science interest expressed by the teens fell into *Sparticl* content categories of Tech & Invention (30%) and Earth & Space (30%). Almost all of the teens found content on *Sparticl* related to at least one of their two categories of interest. Only a few topics that they looked for produced no results: architecture; biomechanical engineering; crime scene investigation; floating; psychology; social media; sociology; tides; time.

As shown in the chart, the teens' initial and subsequent explorations of *Sparticl* exposed a large majority of participants to resources from all of the major content categories. Boys chose significantly more resources in the Tech & Invention category than girls did (means = 6.1 vs. 3.6);\(^5\) whereas girls chose significantly more Body & Brain resources than boys did (means = 6.7 vs. 2.1).\(^6\)

Each *Sparticl* resource is also categorized according to its major type of medium. *Video*, *Game*, and *Text* refer to resources that present respectively a video, a game to play, or a mostly text article. *Interactive* is a quiz or a presentation that you can click on to interact and change what is being displayed. *Images* typically present a gallery of pictures. *Activity* describes an activity that you can try off-line. *Profile* focuses on a scientist.

As shown in the chart, a large majority of the participants made choices that included resources classified as text, video, game, and interactive. Those who used more resources tended to use more text \(r = .71\) and more video \(r = .81\). Text and video are the most common resources on *Sparticl*, comprising 37% and 27% of resources respectively (see type distribution at bottom of the chart).

\(^5\) *t*-tests applied to two independent samples assess the difference between means, in this case boy and girl mean number of resources for the content category. *t*(55) = 2.47, *p* = .007.

\(^6\) *t*(55) = 3.33, *p* = .002.
ENGAGEMENT WITH SPARTICL

I liked how there were a wide variety of topics you could look at.
And there were questions that you could answer and you could get extra points.
And it wasn’t boring! It was very cool!

...13 year old African-American Female, after using Sparticl

All teens enjoyed exploring Sparticl because of the range of information available, the ease of use and the variety of learning formats, particularly the game format. However, they raised concerns about inoperable and/or slow external sites, issues of usability, and the limited range of topics. Four of ten teens described earning points as motivational, and two of ten felt that points were fun or interesting; yet two of ten participants reported that they did not understand the purpose of points.

Appeal of exploring Sparticl. As illustrated in the chart, all participants (100%) enjoyed exploring Sparticl, with 55% enjoying the site “very much” and 45%, “somewhat.” Participants who enjoyed exploring the Sparticl website “very much” chose significantly more game resources (mean = 4.4) than those who enjoyed the site “somewhat” (mean = 2.4). No other variables related significantly to Sparticl appeal.

What was most liked. Asked what they liked most about Sparticl, users noted most frequently the range of information available (52%), the user friendliness of the site design (33%) and the variety of learning formats (27%):

- 52% liked that the Sparticl site was informative with many different topics; e.g.,

I liked that it had a lot of resources to explore various topics. This site would be extremely helpful if you had a science project or homework. I especially enjoyed articles about the human body, heredity, and nature. My favorite was the video about Albert Einstein’s brain.

---

7 t(55) = 2.64, p = .01.
• 33% liked that the Sparticl site was user-friendly; e.g.,

It was very interesting that they had things that were relevant, unique, and kind of popped up on the home page. They had different slides, like “Check this out” that’s related to the Olympics or “This is cool” to think about how things taste. It was very appealing, very interesting to look at. There were different features all over page. It was very easy to use as well.

• 27% liked the variety of learning formats that Sparticl offered; e.g.,

It has different ways to learn about things (example: videos or reading an article). It was easy to use because I learn best from videos and things and for most things it had a video. My eyes get really tired from reading the computer, so I am glad that they had video.

Feelings about earning points\(^8\). Teens felt that earning points on Sparticl motivated them to interact more with the site (39%). Earning points was a fun and interesting activity (22%) and gives the site a competitive aspect (11%). However, some teens did not understand the purpose of earning points (20%), did not care about the points (1%) or did not feel points were appropriate for an informational website (1%). Some users also wanted more opportunities to earn points and a different return for their points.

• 39% felt that earning points was motivational; for example:

I liked it because it kept me wanting to learn more, and by earning more points it made learning about these topics fun. It kept me like addicted to it a lot. It really engaged me and it was really fun.

• 22% thought that earning points was fun; for example:

I loved it! It made it really fun and it was something that made me look forward to going on the site! I loved that you could earn points and enjoyed being quizzed.

• 20% remarked that the point system was confusing; for example:

I thought it was cool but I was not sure what it was for.

I didn’t understand about how to earn points; I didn’t really understand what points did.

• 11% liked the competitive aspect of the point system; for example:

I loved that idea! It made the website much more fun and competitive. I loved the way it worked, and I think it was a wonderful thing to add to the website.

\(^8\) See pages 4-5 for an explanation of how users earn points on Sparticl.
What was not liked. Asked what they did not like about Sparticl, users noted most frequently technical problems about inoperable sites or slow loading (36%), user friendliness of the site design (25%) and a lack of topics or information (20%):

• 36% reported technical problems with their use of Sparticl; e.g.,

Not all of the games and articles worked. My least favorite part of Sparticl was that some of the pages loaded slowly.

I have a desktop computer and an iPad. When I went on the desktop computer the games were working fine, but when I went on my iPad, the games didn't show up.9

• 25% described a range of usability issues, both with Sparticl and the external sites; e.g.,

That I couldn't find the answer to the question easily. I had to read a lot of information to get to it.

I thought that it was sometimes a little confusing on whether you were on Sparticl or one of the links.

I did not like how there would be one quiz question for you to answer that covered multiple articles/videos. I feel that it would be better if there were a quiz question for each article/video.

• 20% felt there was a lack of topics or information; e.g.,

That some of the categories only had a video to watch and did not capture the whole aspect of the topic. At some points it was just a lot of information and not enough interactive things.

VALUE OF SPARTICL

I like that while Sparticl is useful for ideas for school or for science fair projects, or just help for school in general, it is also really fun. I love the combination of the videos, games, and articles. I loved the competition they had for when you spent time on a website. I think all these facts combined makes it likely for me to come back.

...14 year old White Male, after using Sparticl

9 Many of the curated games are in Flash, which does not operate on Apple platforms, but does on other platforms.
Sparticl was valued by the teens: A majority reported that they will return to Sparticl either for help with a school project or topic or because the site provides interesting information. Most users, particularly the girls, were likely to recommend Sparticl to others.

Likelihood of returning to Sparticl. The chart shows that a plurality (45%) of teens think they are “very likely” to return to Sparticl in the future. Those more likely to return to Sparticl also enjoyed exploring Sparticl more; reported more enjoyment in watching, reading or hearing about STEM outside of school; and reported visiting informational websites for their own interest 3 or more times a week.

Teens were most likely to return to use Sparticl for projects, research and help related to their schoolwork (61%) or because the site provided interesting content (45%):

- 61% were likely to return to Sparticl when they need information for a school project or help to understand a school topic; for example:

  I would likely return to Sparticl again because it was very informative and easy to understand. If the teacher didn’t explain a topic very well, Sparticl might explain it better. It would also be helpful for future projects and homework questions.

- 45% were likely to return to Sparticl because the site provided interesting information; for example:

  I am very likely to use Sparticl again just because I enjoyed reading about the different things being discovered in science and how it is related to me or the whole world even.

---

10 With categorical data, Chi-square tests whether there is a relationship between proportional distributions of the two variables, in this case: returning to Sparticl and enjoyment of Sparticl. $\chi^2 (2, N = 64) = 14.74, p = 0.0006$.

11 $\chi^2 (4, N = 64) = 12.96, p = 0.01$.

12 $\chi^2 (2, N = 64) = 7.47, p = 0.02$. 

Multimedia Research 14

Sparticl Evaluation
Those who felt that they were only “a little” likely to return to Sparticl gave a variety of reasons:

*I am a little likely to use Sparticl again because, although it is a pretty fun, interesting way to learn, there are limited topics covered on it that interest me, and I don’t see the point in researching topics that I am not very interested in and will never be tested on.*

**Likelihood of recommending Sparticl.**

Teens were likely to recommend Sparticl to others, with 39% of the participants “very likely,” 45%, “somewhat likely,” and 16%, “a little likely.” Those who enjoyed Sparticl “very much” were more likely to recommend the site compared to those who enjoyed the site “somewhat.”

Girls also were significantly more likely than boys to make such a recommendation (see chart).

**Search experiences.** Teens were not asked directly to compare their experience with Sparticl to their experience searching Google, but in responding to other questions several spontaneously mentioned search routines that reflect on the value of Sparticl. The users valued Sparticl because it has pulled together the best STEM websites in one place, but users also found the keyword search routine and limited resources to be a disadvantage.

*From now on I’ll definitely go on there and look for anything I need to research because it’s harder to go out on like Google, for instance, and choose. You have all these options and thousands and thousands of hits for each category, but it is hard to determine which ones are good. And so Sparticl has simplified the process.*

*The only thing I did not like about Sparticl was the SEARCH browser. It was not very good at finding one specific answer to a question, you had to search a topic, not a question. For example, if you wanted to find out how phones worked, you had to search "phones" instead of "How do phones work?"

---

13 $\chi^2 (2, N = 64) = 15.00, p = 0.0006.$
14 $\chi^2 (2, N = 64) = 6.03, p = 0.05.$
**I remember when I was on there looking about planes and flying, there was something about why flying wouldn’t work as a super power. I felt that that was actually pretty funny and interesting material -- that I shared actually with a lot of my friends and family.**

...13 year old Pacific Islander Male, after using Sparticl

**Sharing Sparticl.** Two-thirds (64%) of participants told friends or a teacher about the website during their two week exposure. Those who told non-family members about Sparticl activated significantly more questions and acquired significantly higher points on average compared with those who did not talk about the website.¹⁵

Eight out of ten teens (81%) reported sharing with family and friends Sparticl content that they found memorable, helpful and clear; and in many cases, they shared specific factual information, while 11% spontaneously reported co-viewing with friends or family. Teens who shared content experienced more content categories than those who did not share.¹⁶

Our participants shared a range of content as illustrated below:

*I told my family about glaciers and stuff, and I was kinda helping myself because I took a class and had a test on mass movement and that video really helped. I was like: ‘oh I already know this stuff’*

*I just told my friends about how I saw something about the topic that we’re learning in science right now, and so I told them that if they were having any trouble they could check out that website and it might clear up anything; if they had questions about it. We’re learning about the three laws of motion, Newton’s three Laws, and so I saw something on there about the second law and how there’s a story about the second law that explains it really well.*

---

¹⁵ $t (54) = 2.21, p = .03$; mean questions = 13.0 vs. 5.7; $t(55) = 2.62, p = .01$. mean points = 75.9 vs. 49.6.

¹⁶ $t (15) = 2.73, p = .008$; mean categories = 5.2 vs. 4.3
Two-thirds of our teens had never heard of 3M prior to exposure to Sparticl. The use of Sparticl significantly increased teens’ awareness of 3M and led them to conclude that the company cares a lot about helping youth learn about science and science careers. Half of the participants recognized that 3M had made Sparticl possible.

Companies caring about youth. Before and after exposure to Sparticl, the online surveys asked participants to rate how much each of five companies cared about helping young people learn about science and science careers. Percentages of participants choosing from among five ratings appear in the table below in pre/post order for each company.

<table>
<thead>
<tr>
<th>Company</th>
<th>Never heard of Company</th>
<th>Company cares not at all</th>
<th>Company cares a little</th>
<th>Company cares somewhat</th>
<th>Company cares a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M</td>
<td>65% / 49%</td>
<td>6% / 2%</td>
<td>5% / 5%</td>
<td>14% / 11%</td>
<td>10% / 33%</td>
</tr>
<tr>
<td>Bayer</td>
<td>63% / 62%</td>
<td>8% / 5%</td>
<td>11% / 11%</td>
<td>11% / 10%</td>
<td>6% / 13%</td>
</tr>
<tr>
<td>Verizon</td>
<td>2% / 1%</td>
<td>17% / 16%</td>
<td>40% / 25%</td>
<td>30% / 38%</td>
<td>11% / 19%</td>
</tr>
<tr>
<td>Toyota</td>
<td>2% / 2%</td>
<td>16% / 14%</td>
<td>37% / 27%</td>
<td>35% / 37%</td>
<td>11% / 21%</td>
</tr>
<tr>
<td>Boeing</td>
<td>46% / 43%</td>
<td>2% / 5%</td>
<td>6% / 5%</td>
<td>13% / 14%</td>
<td>33% / 33%</td>
</tr>
</tbody>
</table>

Teen ratings of 3M changed significantly after exposure to Sparticl. As indicated in the “never heard of” column in the above table, significantly more teens became aware of 3M after using Sparticl. Also after using Sparticl significantly more teens gave 3M higher ratings in terms of caring about helping young people learn about science and science careers.

---

17 Note that Boeing has a unit in St. Louis, one of our research sites. All teens at that site were familiar with the company and thought it cared a lot.

18 McNemar Test of Paired Proportions tests the equality of proportions in the pre-survey compared with the post-survey; two-tailed \( p = .009 \)

19 \( \chi^2 (9, N = 21) = 16.72, p = 0.05 \).
After exposure to Sparticl, teens identified which of the five companies helped or did not help make the website for teens possible. More than half (53%) of the teens voted that 3M helped make Sparticl possible.

<table>
<thead>
<tr>
<th>Company</th>
<th>Helped make Sparticl possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M</td>
<td>53%</td>
</tr>
<tr>
<td>Verizon</td>
<td>33%</td>
</tr>
<tr>
<td>Boeing</td>
<td>33%</td>
</tr>
<tr>
<td>Toyota</td>
<td>25%</td>
</tr>
<tr>
<td>Bayer</td>
<td>9%</td>
</tr>
</tbody>
</table>

**IMPACT ON INTEREST IN STEM JOBS OR CAREERS**

On each of the websites, there were usually like biographies, so I could see that there were so many more jobs in science than I ever thought that there was. I always think that there’s the general jobs but I didn’t know that there was specific jobs like working on how to clone animals and stuff.

...13 year old White Female, who viewed 5 Profiles and changed from “not at all” interested in a STEM career before Sparticl to “a little” interested after

Exposure to Sparticl significantly increased interest in STEM jobs or careers in 23% of our teens. Two-thirds of participants reported learning from Sparticl about STEM jobs or careers. Sparticl raised teens’ awareness of the wide range of STEM fields and raised awareness of specific jobs within fields.

**Career interest.** Before and after exposure to Sparticl, participants were asked how interested they were in a job or career in science, technology or engineering when they get older. The table below shows that most of the teens were “somewhat” interested both before and after using Sparticl; however, there was a statistically significant increase in interest in a STEM job or career after using Sparticl.\(^{20}\) Looking at individual changes in interest, 69% of the teens

\(^{20}\) Wilcoxon matched-pairs signed ranks, \(N = 64, z = 1.93, p = .03\), one-tailed.
maintained the same level of interest both before and after using Sparticl; 23% of teens increased in their interest; and 8% reported a decrease in interest.

<table>
<thead>
<tr>
<th>Interest in a STEM job/career</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very interested</td>
<td>25%</td>
<td>34%</td>
</tr>
<tr>
<td>Somewhat interested</td>
<td>48%</td>
<td>41%</td>
</tr>
<tr>
<td>A little interested</td>
<td>19%</td>
<td>23%</td>
</tr>
<tr>
<td>Not at all interested</td>
<td>8%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Career information. In the interview after experiencing Sparticl, teens were asked what they learned about jobs or careers in science, technology or engineering. Over one-third (36%) of teens, mostly girls, responded that they learned there are many more jobs available in more fields than they thought. Another 28% of participants, mostly boys, described specific jobs or careers.

- 36% reported that the STEM field has many more jobs and careers than they thought; for example:

  There are a lot more jobs and careers than I thought there would be. The different jobs can have a lot more people interested in learning about the science for these jobs.

- 28% recalled learning about specific jobs or careers; for example:

  I learned about the jobs that some people have that they go out and research animal behavior...jobs in medical fields where doctors studied Einstein’s brain...jobs in studying the laws of the world and understanding how ice being a solid itself is much more slick than concrete or wood and then there are scientists to combine things and make things like chocolate and perfume.

I read articles on cloning about trying to save wildlife like the lions or the tigers, and it was actually relevant to something that we were talking about in class today, which was kind of cool that I learned and already knew about it. I had something to say – I really liked that! ...My teacher was talking about cloning, and I brought up the topic of cloning of big cats to try to save their numbers....

**So I had something to contribute because of the Sparticl website.**

...13 year old African-American Female, after using Sparticl
In the post-interview, teens reported what they learned about the topics in which they had expressed interest prior to using Sparticl, and they were also asked to describe other interesting new information they recalled from their exploration of the website. For each of the five main Sparticl content categories, the open-ended recall responses were coded into three themes:

1) Listings of names of a resource topic (e.g., Some articles about poison dart frogs);
2) Statements of specific facts (e.g., There are three different types of volcanoes: composite, cinder cone and one other); and
3) Descriptions of causes, relationships or processes (e.g., How chocolate is good for your heart and it keeps you less stressed)

All teens recalled learning from at least one Sparticl content category, and most teens recalled topics or information from two (42%) or three (32%) of the five main categories. Across all categories, over half of the teens recalled at least one fact from their Sparticl exploration (53%) and described at least one cause, relationship or process (52%).

**Earth & Space.** Teens opened 1 to 35 Earth & Space resources. Two-thirds (67%) of the teens recalled topics in this category and were exposed to significantly more resources than the one-third (33%) who did not recall Earth & Space topics. Participants frequently noted black holes, climate change, hurricanes, various planets, and tornadoes.

**Body & Brain.** Under the Body & Brain category, 1 to 38 resources were opened, and 67% of those who opened them could recall something of their content. Those who spontaneously recalled topics in this category were exposed to significantly more Body & Brain resources than the 33% who did not recall such content. Participants frequently mentioned resources about chocolate, color blindness and the brain (brain freeze, concussions, Einstein’s brain, teenage brain).

**Matter & Energy.** One to 25 resources in the Matter & Energy category were opened by 94% of the teens. About half (52%) of these teens spontaneously recalled content in this category and

---

21 $t(50) = 2.98, p < .004$
22 $t(38) = 4.47, p < .0001$
were exposed to significantly more Matter & Energy resources than the other half (48%) who did not recall such content.\textsuperscript{23} Frequent topics mentioned included fireworks, makeup chemistry, science of various sports, and roller coaster energies.

**Living Things.** Teens opened 1 to 30 resources in the Living Things category. Half (49%) of those who saw Living Things resources recalled topics in this category and were exposed to significantly more resources than the other half (51%) who did not mention Living Things topics when asked what they learned from Sparticl.\textsuperscript{24} Additionally, girls were significantly more likely than boys to recall specifics from this category.\textsuperscript{25} Participants most frequently talked about reindeer, dolphins, cats, dogs, hedgehogs, and plants.

**Tech & Invention.** Teens opened 1 to 17 resources in the Tech & Invention category. Almost half (47%) of those who saw resources in this category recalled topics and were exposed to significantly more resources than the other half (53%) who did not recall Tech & Invention topics.\textsuperscript{26} Those who recalled topics and specifics from this category were also significantly more interested in a STEM career both before and after exposure to Sparticl.\textsuperscript{27} Participants frequently noted airplanes, building demolition, microchips, and Rube Goldberg machines.

**Definition and Importance of Science.** Before and after their Sparticl experience, teens were asked how they would explain what science is to someone who has little to no familiarity with science. The open-ended qualitative responses were analyzed inductively by looking at keywords and key phrases. Responses were coded into six themes that were then merged into two larger categories for statistical analysis. One of the large categories focuses on a definition that emphasizes the nature of science and science inquiry, and the other category focuses on the importance of science. The two large categories and themes are described below and illustrated with quotes drawn from both pre and post interviews:

- **Category: Science is a body of knowledge resulting from systematic study:**
  - Science is explanation: of how things/the world works, what we know;
  - Science is system of acquiring knowledge: a way, method, process of study, research;
  - Science has many fields of study.

\textsuperscript{23} t (51) = 2.39, \( p = .02 \)
\textsuperscript{24} t (37) = 3.87, \( p = .0004 \)
\textsuperscript{25} \( \chi^2 \) (2, \( N = 59 \)) = 5.67, \( p = 0.05 \).
\textsuperscript{26} t (42) = 2.35, \( p = .02 \).
\textsuperscript{27} Pre \( \chi^2 \) (3, \( N = 57 \)) = 12.73, \( p = 0.005 \). Post \( \chi^2 \) (3, \( N = 57 \)) = 8.21, \( p = 0.04 \).
As shown in the table below, before and after exploring Sparticl, 78% of the teens provided science definition responses falling into the above category [see upper left table cell, Pre-Post Category Present]. Exposure to Sparticl did not stimulate statistically significant change in this category, although 11% did add these themes in their post-responses [see lower left table cell, Pre Absent, Post Present].

<table>
<thead>
<tr>
<th>Category: Science is a body of knowledge resulting from systematic study</th>
<th>Post Sparticl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category Present</td>
</tr>
<tr>
<td>Pre Sparticl Category Present</td>
<td>78%</td>
</tr>
<tr>
<td>Pre Sparticl Category Absent</td>
<td>11%</td>
</tr>
</tbody>
</table>

- **Category: Science is important:**
  - Science is applied to human needs: useful, helpful, creative, contributes to society;
  - Science makes up everything, is everywhere;
  - People should know/learn science; it’s fun, interesting.

As shown in the table below, 34% of teens included the importance of science in their definition both before and after using the website. The proportion of participants who included this category in their comments after their Sparticl experience increased significantly, with 25% of the teens adding that science is important to their definition of science.\(^{28}\)

<table>
<thead>
<tr>
<th>Category: Science is important</th>
<th>Post Sparticl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category Present</td>
</tr>
<tr>
<td>Pre Sparticl Category Present</td>
<td>34%</td>
</tr>
<tr>
<td>Pre Sparticl Category Absent</td>
<td>25%</td>
</tr>
</tbody>
</table>

\(^{28}\) McNemar Test of Paired Proportions, \(p = .006\)
I wonder what causes... *dust devils.*  
I would like to experiment ...*with the science of chocolate.*  
I would like to search for answers to questions about... *concussions.*

...13 year old White Male, after exploring Sparticl resources

Exposure to *Sparticl* resources increased the specificity of topics teens were curious about and increased their interest in topics. In their post-survey, half of the teens reported that their curiosity was sparked by something on *Sparticl* and that they would go to the website for answers to their questions.

In pre and post online surveys, teens completed three sentences about their science curiosities and also rated on a 4-point scale how interested they were in learning the answers:

- *I wonder what causes...*  
- *I would like to experiment with...*  
- *I would like to search for answers to questions about...*

Both before and after exposure to *Sparticl*, the most popular content categories related to each of these sentence stems remained the same. Teens *wondered what causes* and *would like to search for answers to questions* in categories of Body & Brain and Earth & Space. Teens *would like to experiment with* topics mainly in categories of Matter & Energy. Many topics that teens were exposed to in *Sparticl* resources were not listed as curiosities prior to using *Sparticl* but appeared in their list of post-exposure curiosities; for example, *black holes, chocolate, concussions, dry ice, fireworks, and lasers.*

Teens were also asked about the role that *Sparticl* played in their post-survey answers for the three sentence stems:

- 51% felt that something on the website sparked their curiosity about the topic they chose for the sentence stem *I wonder what causes...*  
- 55% reported that something on the website sparked their interest in the topic entered for the sentence stem *I would like to experiment with...*  
- 55% agreed they will go to the *Sparticl* website to search for answers about the topic they put in the sentence stem *I would like to search for answers to questions about...*
In some cases, post-content curiosities became more specific based on those resources teens saw on Sparticl. For example:

- Resources on the Olympics were available during the two week treatment period, so a teen who was interested in the body prior to using the site became more focused on the body in relation to athletic endeavors, as illustrated below:

<table>
<thead>
<tr>
<th>Sentence stem</th>
<th>Pre Response</th>
<th>Post Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I wonder what causes...</td>
<td>...your brain to work and what makes your body move.</td>
<td>...athletes to be able to get enough speed to go in the air on half pipe.</td>
</tr>
<tr>
<td>I would like to experiment with...</td>
<td>...how the brain works.</td>
<td>...trying to see how much energy it would take to get a snow boader up the pipe by making a smaller model.</td>
</tr>
<tr>
<td>I would like to search for answers to questions about...</td>
<td>...how the body works.</td>
<td>...things that have to do with the brain.</td>
</tr>
</tbody>
</table>

- The teen below was interested in physics and animal behaviors prior to experiencing Sparticl. Within her general content interests, the teen saw Sparticl resources about ice, chocolate and dogs and focused her post-experience curiosity toward these specific topics, as illustrated below:

<table>
<thead>
<tr>
<th>Sentence stem</th>
<th>Pre Response</th>
<th>Post Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I wonder what causes...</td>
<td>...the redness associated with sunsets/sunrises.</td>
<td>...ice to be so slippery, even though it is a solid.</td>
</tr>
<tr>
<td>I would like to experiment with...</td>
<td>...physics related topics.</td>
<td>...different varieties of chocolate making and uses for chocolate.</td>
</tr>
<tr>
<td>I would like to search for answers to questions about...</td>
<td>...animal behaviors.</td>
<td>...even more questions and answers about dog behavior because Sparticl gave me much more insight into the field, and I would like to look for more.</td>
</tr>
</tbody>
</table>
IMPACT ON VALUE OF SCIENCE

Pre-Sparticl: An important part of our society is definitely cars and automobiles. And they only work with the help of science and chemistry and engineering.

Post-Sparticl: I think that for science to move forward, there are still certain things that we don’t know, and I think we need science to figure those things out, and definitely move forward. I learned about a large particle accelerator that was designed to experiment with particles, essentially just smashing them together and seeing what happens. And I think there would be some very important and interesting explanations that could come out of that.

...13 year old White Male, before and after exploring Sparticl resources

After exposure to Sparticl, teens increased their valuation of the importance of knowing and studying science and the utility of science in solving everyday problems. When asked for an example of how science, technology or engineering is valuable to society, 38% of teens specifically referenced a Sparticl resource.

In online surveys before and after exploring Sparticl, teens rated their agreement with five randomly ordered statements about the value of science.29 Although teens on average agreed with the value of science statements prior to exposure to Sparticl, their website experience significantly increased teens’ agreement with three of the five statements:

- It is important to know science in order to get a good job;
- Most people should study some science; and
- Science is useful in helping to solve the problems of everyday life.30

Pre and post mean ratings for each statement are shown in the table on the next page.

---

29 The statements are the Value of Science in Society subscale of the modified Attitude Toward Science Inventory described in Weinburgh, M.H. & Steele, D. (2000). The modified Attitudes Toward Science Inventory: Developing an instrument to be used with fifth grade urban students. Journal of Women and Minorities in Science and Engineering, 6,87-94.
30 One-tailed paired t(63) = 1.87, p = .03; One-tailed paired t(63) = 1.88, p = .03; One-tailed paired t(63) = 2.43, p = .009.
### Value Statement

<table>
<thead>
<tr>
<th>Value Statement</th>
<th>Strongly Disagree = 1</th>
<th>Disagree = 2</th>
<th>Undecided = 3</th>
<th>Agree = 4</th>
<th>Strongly Agree = 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is important to know science in order to get a good job. (significant change)</td>
<td></td>
<td></td>
<td></td>
<td>Pre mean = 3.41</td>
<td>Post mean = 3.64</td>
</tr>
<tr>
<td>Most people should study some science. (significant change)</td>
<td></td>
<td></td>
<td></td>
<td>Pre mean = 4.14</td>
<td>Post mean = 4.33</td>
</tr>
<tr>
<td>Science is useful in helping to solve the problems of everyday life. (significant change)</td>
<td></td>
<td></td>
<td></td>
<td>Pre mean = 4.20</td>
<td>Post mean = 4.44</td>
</tr>
<tr>
<td>Science is of great importance to a country’s development.</td>
<td></td>
<td></td>
<td></td>
<td>Pre mean = 4.42</td>
<td>Post mean = 4.39</td>
</tr>
<tr>
<td>Science is helpful in understanding today’s world.</td>
<td></td>
<td></td>
<td></td>
<td>Pre mean = 4.56</td>
<td>Post mean = 4.64</td>
</tr>
</tbody>
</table>

In the pre and post interviews, teens were asked to give an example of how science, technology or engineering is valuable to our society. These responses were coded into 7 themes, briefly described and illustrated below. The percentages of responses falling into 5 of the 7 themes increased from pre to post interviews, although not to statistical significance.

- **Engineering is valuable for transportation and building**: Pre = 42%; Post = 45%
- **Science is valuable for understanding the world, solving problems**: Pre = 36%; Post = 42%
- **Science, technology, or engineering is valuable in medicine**: Pre = 26%; Post = 31%
- **Science, technology, or engineering helps us survive, makes life comfortable**: Pre = 20%; Post = 28%
- **Technology supports easier, faster communication**: Pre = 27%; Post = 19%
- **Science, technology or engineering helps us understand and solve environmental issues**: Pre = 8%; Post = 14%
- **Technology, particularly the Internet, helps transfer knowledge and helps us learn**: Pre = 17%; Post = 14%
The teens in this study valued Sparticl as intended by TPT, as a tool to explore and learn about science, technology and engineering. Teens recognized that Sparticl provides searchable high quality STEM content in an easily accessible fashion, unlike commercial search engines. Users enjoyed exploring across all the available content categories and variety of learning formats. Although the game format currently comprises a relatively small proportion of the available resources, games were significantly related to teen enjoyment in exploring Sparticl. Earning points via the resource quiz questions also motivated site visitors to explore more. Expanding both game resources and adjunct questions are likely to increase user engagement.

Through exploration of Sparticl resources, two-thirds of teens learned about STEM careers and became aware of the wide range of STEM fields and specific jobs within fields. One-quarter of teens significantly increased their interest in a STEM career after working with the website, whereas some others found their current choice of career to be reinforced by what they experienced. After using Sparticl, teens also increased in their agreement that most people should study some science and that knowing science is important to get a good job. Sparticl’s diversity of content effectively broadens and deepens what teens define as a career and the value that teens give to science. Additional features like career self-assessment tools could play an important role in guiding users, since early high school is a time during which youth make school course choices that impact their future with respect to STEM careers.

As might be expected, the more resources viewed, the more teens recalled about Sparticl content in terms of facts, causes, processes or relationships. Some content recalled was related to their prior interests, for example, sports physics, makeup chemistry or pets; other content was unique to Sparticl and unusual such as science of chocolate, brain freezes and reindeer eyes. Additionally, teens noted how Sparticl resources helped them personally, for example, learning a new skateboard trick, a way to avoid disease, and how to make invisible ink. The ability to locate familiar topics through the Sparticl search feature and drop-menus and the serendipity of discovering novel and/or practical content through carousel highlights and sidebar suggestions appealed to site visitors and supported learning and recall.

This evaluation also explored how Sparticl might affect teens in ways not typically associated with an informational website: As a result of their Sparticl experience, STEM topics that teens were curious about became more specific and engendered higher interest; teens’ definition of science expanded to include the idea that science is important; and teens increased their recognition of the value of science, technology and engineering in everyday life.
In its primary goal as an information website, Sparticl generated in the teens a significant amount of face-to-face sharing of information acquired from the resources. Eight of ten teens shared memorable Sparticl content with others. This active sharing gratified teens in ways that an online social exchange cannot – teens reported contributing to class discussions; helping friends with schoolwork; and bolstering their self-identity by explaining new ideas to their parents and older siblings.

On the other hand, the teens did not join in the online Sparticl social community of rating, commenting, sharing or recommending resources, despite the fact that 80% of the participants frequently use social media sites like Facebook. This evaluation did not explore teen reactions to the community features of Sparticl, so it is not known if teens were unaware of the related point incentives; or disinterested in the available mechanisms of involvement; or did not perceive a community that appealed beyond immediate informational gratification. Our teens saw Sparticl as fitting into their lives mostly as a school or project resource rather than as a site for self-expression and participation in affinity groups. Social networks fill a teen need to explore their identity and maintain connections with friends. Sparticl currently has minimal implementation of two features that commonly meet these needs: (1) a profile that represents the personality and interests of the user and (2) facilitated asynchronous engagement with others interested in similar topics. Sparticl’s growth as a social STEM community will need to develop further these features.

Even without online social engagement, 84% of the teen representatives are “very” or “somewhat” likely to return to Sparticl, and 5% of the participants already returned within the month since this evaluation was completed. Those who experience Sparticl appreciate its value, thus attracting new users and registrants is a critical next challenge to the site’s continued success.

*   *   *

Multimedia Research 28 Sparticl Evaluation