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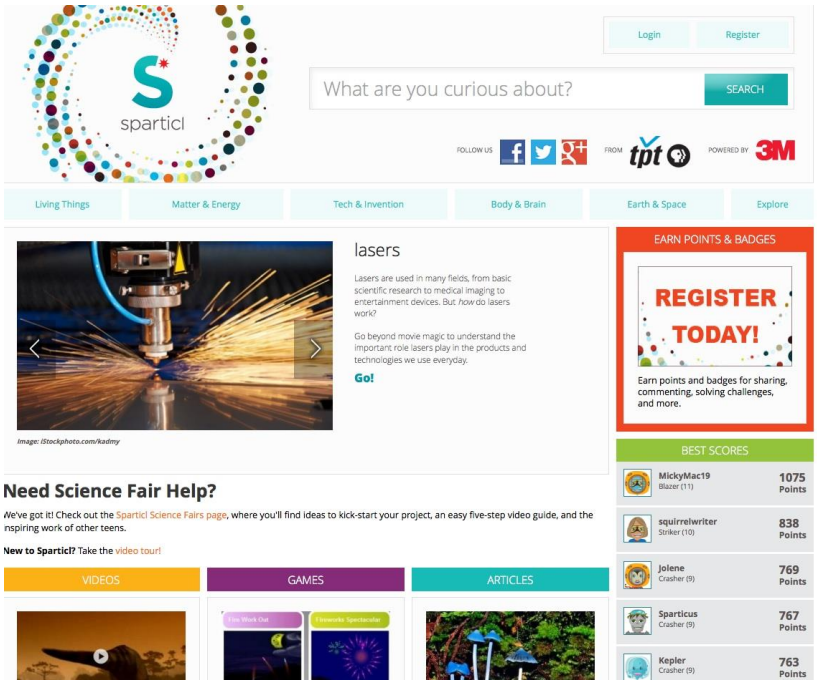
Evaluation of *Spartic!* STEM Website for Teens



Report for Twin Cities Public Television
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EXECUTIVE SUMMARY

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 *Spartic*l broadened teens' definition of science to include the concept that science is important.

***Spartic*l sparks teens' curiosity.** Exposure to *Spartic*l 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 *Spartic*l and that they would go to the website for answers to their questions.

***Spartic*l changes how teens value science.** After exposure to *Spartic*l, 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 *Spartic*l resource.

INTRODUCTION

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.[1] 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.

METHOD

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.

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.[2]

STEM interest levels. During recruitment, potential participants were not told that the website that they would be exploring had STEM content. During recruitment, teens were asked: *Outside of school, how much do you enjoy watching, reading or hearing about science, technology or engineering... and how much do you enjoy watching, reading, or hearing about history or social studies?* The latter question was a throwaway camouflage question. To generalize to teens who are potential users of *Sparticl*, participation in the evaluation required that our 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.

[2] 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 *Spartic*l website.

After the phone interview, researchers emailed participants the *Spartic*l website URL, their individual login information, and a request to begin their exploration of *Spartic*l by looking for the topics described in their phone pre-interview. The email listed topics specific to each teen. *Spartic*l 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 *Spartic*l 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 *Spartic*l 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.

Qualitative data from interviews were sorted into categories by keyword and theme in relation to the evaluation issues of appeal, usability, value and learning. Categories are presented as frequencies in the text, and verbatim quotes from participants are presented to illustrate each category and enrich the quantitative data set.

USE OF *SPARTICL* CONTENT AND FEATURES

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 and it says, okay, here are 10 articles on dog comprehension or something like that and they have 10 articles on that specific category; and you can choose from those 10 and you know all of them are reliable. And they provide really detailed and specific information and they are useful. They are not just any old site, they have selected really high quality ones

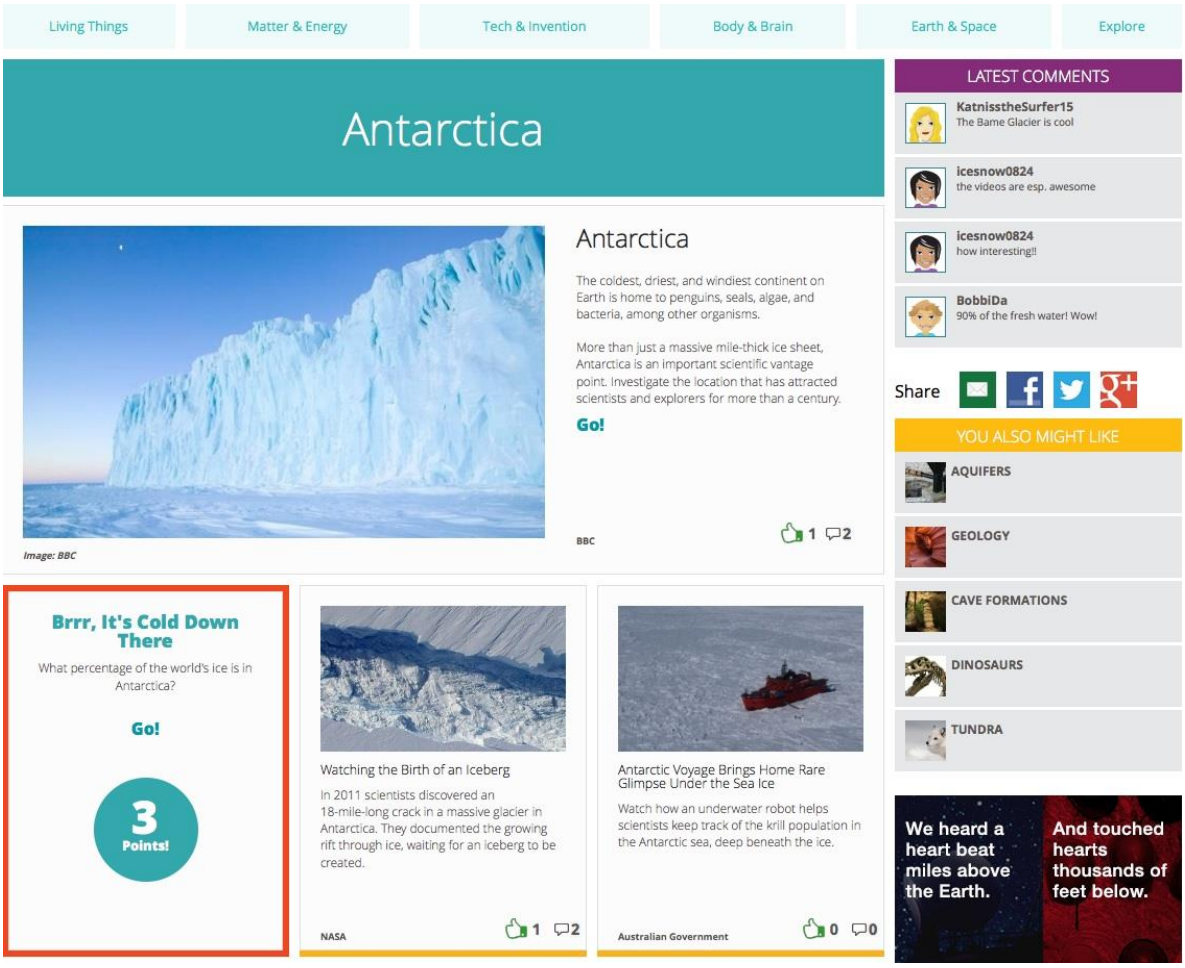
…13 year old White Female, after using Sparticl

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.* Although the original evaluation plan was to rely on duration statistics from the *Sparticl* site based on user logins and Google analytics, those data were found to be unreliable because of artifacts in how Google measures time-on-site; thus, duration estimates are based on participant self-report. 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. To obtain points, a user registers on the site, accesses content, answers content-related questions, and/or rates, comments, shares content or invites others to the site. A user earns 10 points for registration, so all of our participants began their *Sparticl* use with an initial 10 points.

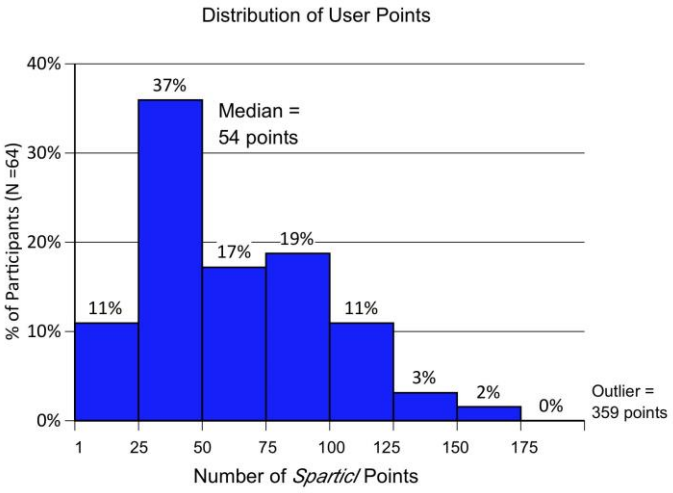
To explain the point system further requires explanation of the *Spartic!* site structure: On the *Spartic!* homepage are listed six categories with drop-down sub-categories; for example, the category of Earth & Space has a sub-category of Landforms & Geology. A user who chooses Landforms & Geology sees a page of alphabetized topics with images and text titles; for example, Antarctica, Artic, Cave formations, etc. Choosing a topic, such as Antarctica, brings up a topic page, partially illustrated below. A topic page presents a question related to the topic as well as many choices of titles and images from external resource sites about Antarctica. A resource may appear under more than one topic, and a topic may appear within more than one sub-category.



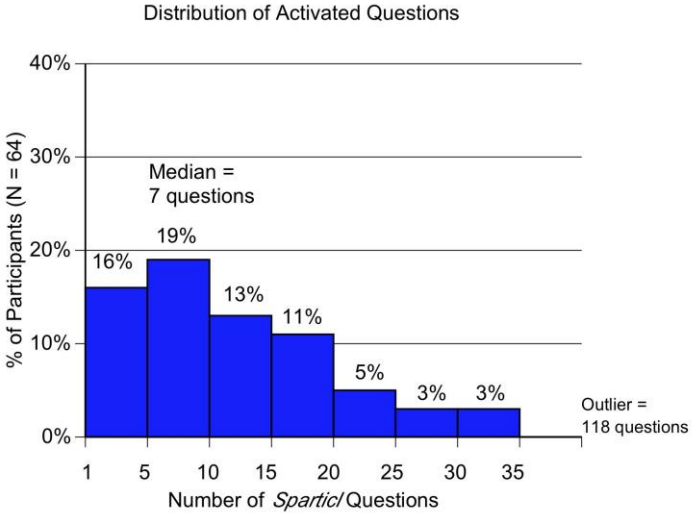
Choosing <Go!> in the question box earns the user 1 point and reveals the multiple-choice responses. Choosing a correct answer earns 3 points for an easy question and 4 points for a hard question. A user earns another 1 point by choosing an external resource site on the topic page (e.g., *Watching the Birth of an Iceberg*) and spending more than 30 seconds on that resource site. Additional points are earned by liking or disliking a resource (1 point), commenting about a resource (5 points), sharing a resource via email, facebook, twitter, google+ (5 points) and recommending a resource to add to *Spartic!* (5 points). Digitally inviting someone to check out *Spartic!* also earns 5 points.

*Spartic*l's current point system thus rewards registration, activating content questions, answering questions correctly, viewing a variety of resource sites, inviting a new user, and participating in the *Spartic*l community around a resource by liking, disliking, commenting, sharing, and recommending. The usernames of the five highest overall point scorers are listed on the home page and currently range from 763 to 1075 points.

Points acquired. In their use of *Spartic*l, our teens earned 18 to 359 points, with half of the participants earning below 54 points and half earning above this median score. The top 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 bottom 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.

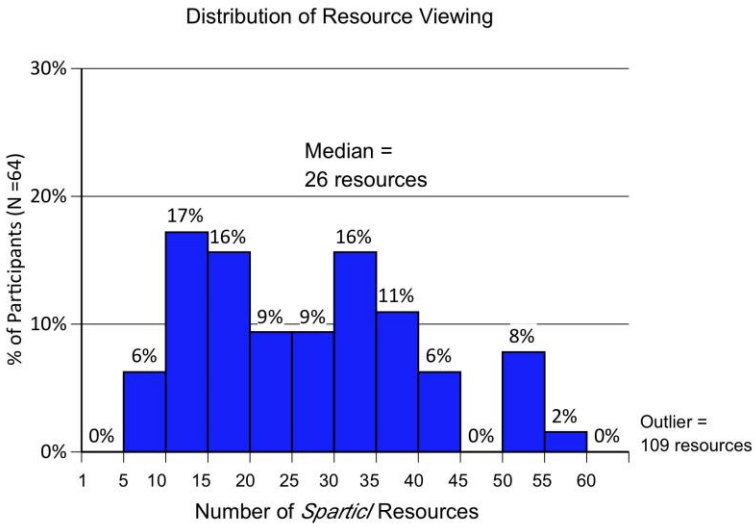


Correct answers ranged from 20% to 100% correct, with an average 50% correct. The higher the number of correct answers, the higher the point total overall (r = .91).[3] Correct answers contribute to 83% of the variance in the point totals, and number of resources viewed contributes an additional 7% to the point total variance.

Rating, commenting, inviting, sharing activity. Participating in the *Spartic*l community around a resource rarely occurred: Of our 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 *Spartic*l and make a resource recommendation, garnering higher points for such activities. No participant shared a resource during the two week period.

[3] 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.

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. (This outlier participant is a different teen from the one appearing in the previous two charts.)

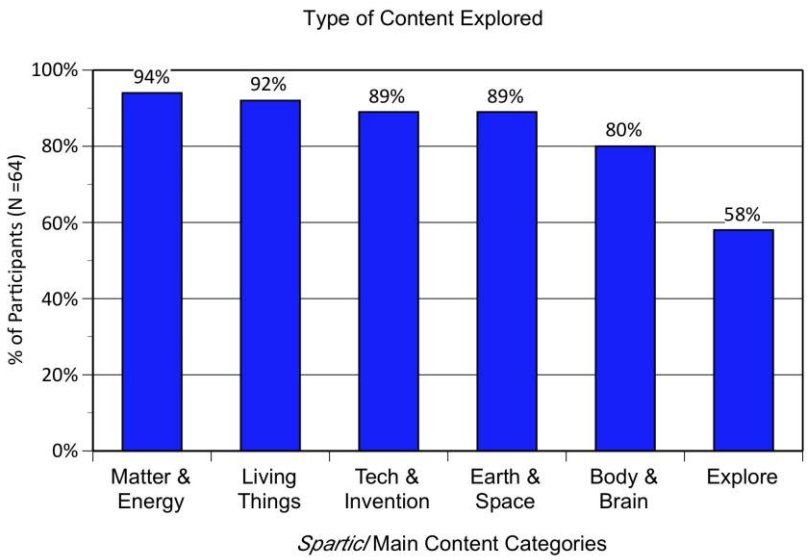


A topic page also presents related topics in a right-hand sidebar titled *YOU ALSO MIGHT LIKE*; for example, the Antarctica topic page illustrated earlier presents five extra topics. Of our teen users, 33% did not notice this feature, 6% were not interested, 52% clicked on this section "at least once," and 9% reported clicking "lots of times." A few teens reported in their interviews serendipitously finding topics they were very interested in through this feature; for example:

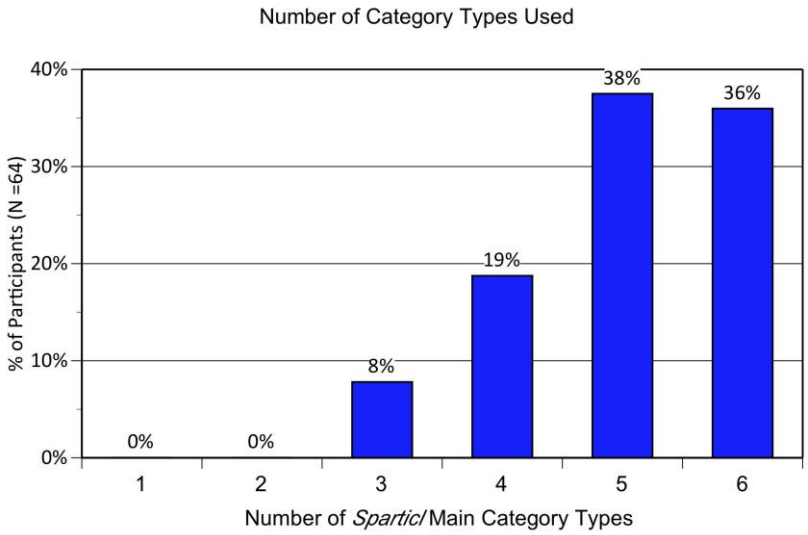
> *After I watched a video about something I researched, I saw on the "you might also like," something about how to make cosmetics. And I found out a lot of interesting things on how they make lipstick and blush and a few other things.*
>
> *I'm interested in just the study of life and the universe, the questions. So I looked it up and I saw something - there was like a link on the side that said "You might like." And it was Albert Einstein's brain, like a video. So I watched some really long videos and I learned that somebody at the hospital has Albert Einstein's brain. And it was a full investigation. It was really cool.*

In order to motivate teens to explore *Spartic*l 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. The main areas of science interest expressed by our teens fell into *Spartic*l content categories of Tech & Invention (30%) and Earth & Space (30%). Almost all of our teens found content on *Spartic*l 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 top chart, the teens' initial and subsequent explorations of *Spartic!* 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);[4] whereas girls chose significantly more Body & Brain resources than boys did (means = 6.7 vs. 2.1).[5]



Three-quarters (74%) of our teens accessed five or six of the six *Spartic!* main content categories (see bottom chart). The remaining quarter of the group viewed three or four of the six categories.

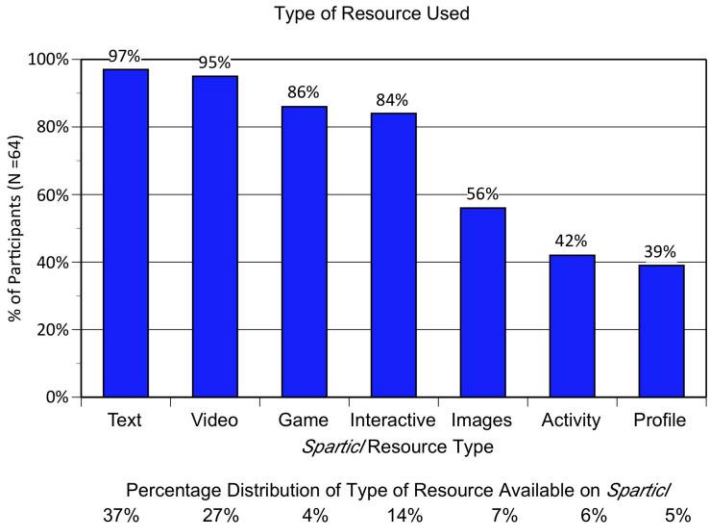


[4] *t*-tests applied to two independent samples assess the difference between means, in this case boy and girl mean number of resources for the content category. $t(55) = 2.47$, $p = .007$.

[5] $t(55) = 3.33$, $p = .002$.

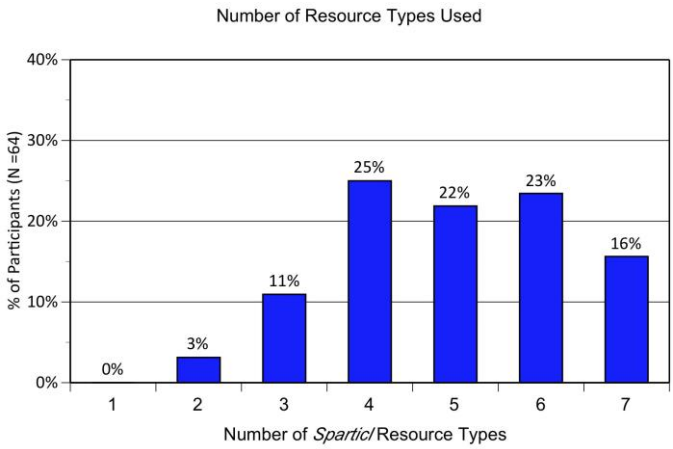
Each *Spartic*l resource is also categorized according to its major type of medium. *Video*, *Game,* and *Text* refer to resources that present respectively a video, a game to play, or a mostly text article. *Interactive* is a quiz or a presentation that you can click on to interact and change what is being displayed. *Images* typically present a gallery of pictures. *Activity* describes an activity that you can try off-line. *Profile* focuses on a scientist. The resource types are presented on *Spartic*l's home page under columns titled Videos, Games, Articles (see home page image on this report's title page). Under the Videos column, the Video type appears. Under the Games column, the Game type appears. Under the Articles column, the Text, Interactive, Activity, Images and Profile types all appear.

As shown in the chart below, a large majority of our 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 *Spartic*l, comprising 37% and 27% of resources respectively (see type distribution at bottom of the chart). Games also received high use, although this resource type comprised a low 4% of the total resources available.



The bottom chart reveals that a majority of the teens were exposed to a majority of the resource types.

The five resource charts indicate that the teens were exposed to a broad expanse of what *Spartic*l offers, a wide range of content categories and resource types.

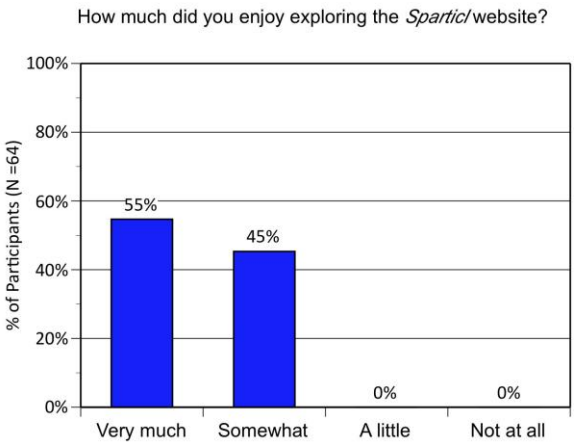


ENGAGEMENT WITH *SPARTICL*

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 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).[6] 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.

[6] $t(55) = 2.64$, $p = .01$.

I liked that Sparticl was not only informative but it was fun and interesting. I loved all of the topics Sparticl had to offer, from how skiing works to giant indoor snow resort located in the middle of the desert!

The thing I most liked about Sparticl was the information it gave me. Taught me a lot of interesting facts that I didn't know.

It had many large topics with smaller subtopics. It explained things very simply and short.

I liked the fact that there was so much to explore on the website.

I liked how there are endless topics, activities and websites to explore.

There was a large variety of sciences to choose from.

- 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. So it was an attractive site, very kid-friendly, and I thought it was really well done and the points earning and the little challenges on the side of everything you read. I think they did a good job in choosing articles that are relevant that you would look for, if you were looking under a certain category on a typical search engine. And I think they created an easier way to find scientific articles that have relevance and value in each category.

I really liked how you could just hit an arrow and move onto the next article about the subject you selected. I REALLY liked the organization. It was very easy to understand.

It was very easy to find things and search things.

I liked how easy it was to navigate and how much interaction there was.

I liked how easy it was to navigate around so many different websites and sources.

The website allowed easy access to many useful sites at one time.

It acted like a mix of a search engine such as Google by taking you to cool new websites, and at the same time had its own information.

I like how it takes stuff that otherwise to look it up would be a pain, but it takes it and puts it in one spot and it makes it easy.

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

I liked that when you searched a topic multiple results came up showing different ways of learning.

It has different ways to learn about things (example: videos or reading an article). It was easy use 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.

It was good. Make sure that there is something for each learning style on the different topics, so if try and get a video or a game or something for each topic. I think there was pretty much all of those, but just to make sure there is, so all learning styles can learn and develop from the website.

It helps students of all kinds to learn effectively.

It gave you the choice to choose a video, game or website about the subject.
I liked the variety in the types of things you could do on the site (ex: watch videos, play games, read articles, etc).
That I could visit the different categories and watch videos about them, I also liked the games and trivia questions. I really liked playing the games and taking the quizzes. It helped show me what I know and what I should be reading for and that type of stuff.

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.
  I did not like that some of the games did not work.
  Some websites it brought me to didn't work.
  Some of games, videos, and articles did not load.
  Sometimes the videos didn't load.
  My least favorite part of Sparticl was that some of the pages loaded slowly.
  I did not like how sometimes I had to click the link to the actual website so that the page looked right.
  How sometimes it took too long to load the web page inside the other web page, when I could just click on the link and go to the actual website (not Sparticl) and it would load faster.
  It would take me to different websites that on occasion would not work and said same things.
  The one thing that I did not like about Sparticl was that sometimes I would want to go see a video and it would bring me to articles instead of videos.
  One of the games, the nano word search, you couldn't see the words because they were stuck and you couldn't scroll down.
  One of the games I tried to get on but it wouldn't let me play it. It was an airplane game called, "Dog Fight - the Great War."
  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.

- 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.
  As you went to the different tabs on the home page, it gave you more options, however I felt like you should be brought to an entire new page and from there choose what you exactly want. Also, when you were brought to a new website from Sparticl, the blue section on the very top of the page was quite annoying and should be reduced to a slightly smaller state. It would say go back to this or this or that. It was very useful, I still want it there, but just a little bit smaller. There was a lot of empty space with no words or anything and it took a lot of the screen. [using laptop].

I'm not sure if it's the browser I was using, [Google Chrome]*, or just the website, but after each page or subject I chose, the Sparticl banner would overlap most of the website, making it difficult or even impossible to view, so that I had to click for (a full page) on another tab.* [using Fujitsu 12"] *On many additional links I clicked, the page would transfer to another website, or would not go back to the original page.*

I did not like that some of the web pages that came up were not completely related to the search.

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

The only thing I didn't like was it was hard to get back to the home page to look at more choices to research.

I thought that there wasn't an easy way to get back to the home.

I was unable to do the quizzes. every time I answered a question, it made me do the same question again, and wouldn't let me go to question 2. Also a few times I had to log out and log back in because it froze or would not respond.

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, so more information could be covered and you aren't just intrigued to search for the answer to the question.

I didn't like that the point system was quite flawed. You could read an article for half an hour and only get one point but click on a whole bunch of links and get a whole bunch of points.

I didn't like how it didn't explain the point system, and I think that there should be an explanation of that. I also think that on the home screen, how there is a list of videos, games, and articles, that those should be hyperlinks to all the videos, games, and articles, instead of just a title.

If you are going to have a "like" button, you have to have a "dislike" button. Otherwise, it feels very immature, and I understand the idea of no dislikes but it is the 'all or nothing' idea. If possible, including dates of articles in the intro might bring some popularity because of current event papers kids are asked to write all the time and it's nice just to know. Love that the site is phone friendly.

When I clicked on Sammy the Flying Squirrel, it traveled to a site with just a bunch of links. I didn't want to click on that. It looked really suspicious.

- 20% felt there was a **lack of topics or information**; e.g.,
  Some of the information that I wanted to learn about was not on the website.
  I didn't like how I couldn't find much information on certain topics like erosion.
  That some of the categories only had a video to watch and did not capture the whole aspect of the topic.
  I really disliked how limited the things to look at were. Also, for some topics the only articles were lesson plans and ideas and it didn't feel like it was for kids it felt like it was for teachers.
  At some points it was just a lot of information and not enough interactive things.
  Information about DNA was difficult to find. The computer section was rather scarce in information.
  Some categories it couldn't find and some things weren't recent data. Or it didn't have any information about it. Example Neanderthals and wolves and dogs
  I didn't like that there wasn't that many topics to choose from within the larger science groups.
  At times when I couldn't find something to read about, it felt kind of boring.
  For the website supposed to be about science and technology, there was not a lot of technology things. There wasn't really a lot on computer and stuff, like I just saw one thing on microchips.

Feelings about earning points[7]**.** 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 earning points because it was good motivation to keep exploring different web sites.
  I think that the point system is quite motivating and is a great idea.
  I thought it was interesting. It's a good way to encourage people to learn new things.
  I think that it was a really cool idea. It made me want to earn more points and look at new topics.
  The feature is an interesting way to get people to search around the site more.
  I liked it because it made me want to do more of them (questions) and it made me want to earn more points.
  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.
  I think the points encouraged me to continue learning about the topic and would check my understanding. It was also very accessible to earn and check up on your points. I noticed that you can gain points and earn points during the website and I thought that really

[7] See pages 4-5 for an explanation of how users earn points on *Sparticl*.

encouraged me to keep reading and learn topics. It also checked my understanding on the topic because I would answer questions and get three points on the side and that would really encourage me to learn new topics.

I thought it was a neat idea to keep kids motivated and making learning a challenge, and fun by getting enough points to level up. I made it to the second level of points.

I thought that the point earning was a great method that appeals to kids and teenagers and will get us more involved and interested about learning these sciency things. The challenges on the side are really neat too.

I think that the points were cool but there should have been more opportunities to earn points.

I thought that earning points by exploring Sparticl is an effective strategy to make kids learn, only I believe that there should be at least one quiz question that you earn points from per article/video.

I liked how on each page there was a question you could answer to earn three points. I liked how you earned a point for looking at each article too, but I think you should earn more points if you spend a longer time on the page.

It is a good thought to have people to explore the site. But some of the badge margins are very large.

I thought it was good encouragement to look at more sites, but it would be better if something more happened from getting more points.

It was a good motivation method, although earning points by staying on a website for a short period of time made me just want to stay on the website until I earned the point, and not read.

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

  It was a fun way to get involved.

  It was fun and I got really excited when I got the points.

  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 I could increase my score to get new profile pictures.

  I loved that you could earn points and enjoyed being quizzed.

  I think it made the website more fun by having you answering questions and getting points but the levels should have something you can unlock.

  It was fun, but I think you should be able to do something with the points. I think that you should be able to do something with the points to encourage people to get more points and work with that.

  It was an interesting feature, but I found it to not be too rewarding, and the ranks had ridiculously high points near the high end of the badge spectrum.

- 20% remarked that the point system was **confusing;** for example:
  I thought it was confusing and not well explained.
  I didn't understand about how to earn points.
  I didn't really understand what points did.
  I don't know what the points are for.
  I liked it but I didn't see the point of it.
  I knew I was earning points but I didn't understand why.
  I liked the quizzes available at the bottom of the page that tested your knowledge of the articles. I just wish that there was an explanation of the point system, as it took me a while to figure out.
  I thought it was cool but I was not sure what it was for.
  The points were super irrelevant to me. I knew how I got them but I didn't know if I was supposed to use them to redeem something or what. I didn't see a purpose for the points system.

- 11% liked the **competitive aspect** of the point system**;** for example:
  It was fun to see how many points I had compared to others.
  I think that would be a cool motivator, especially if a class used it and made it a competition.
  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. I liked how they had competition, the point system like if you go on different websites you can get points for seeing or just checking them out- I like that, I thought it was a really cool idea.
  I thought it was interesting and added a competitive aspect to the website.
  It's cool I guess. It makes it sort of competitive.

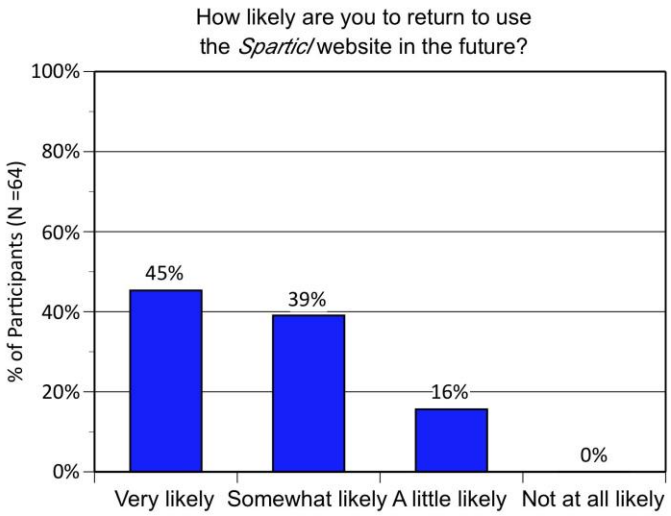
VALUE OF *SPARTICL*

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 to the website.

…14 year old White Male, after using Sparticl

***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;[8] reported more enjoyment in watching, reading or hearing about STEM outside of school;[9] and reported visiting informational websites for their own interest 3 or more times a week.[10]



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%):

[8] 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*. χ^2 (2, N = 64) = 14.74, p = 0.0006.

[9] χ^2 (4, N = 64) = 12.96, p = 0.01.

[10] χ^2 (2, N = 64) = 7.47, p = 0.02.

- 61% were likely to return to *Sparticl* when they **need information for a school project or help to understand a school topic;** for example:
  It helped me do some homework that was assigned, so it can be useful for that too.
  I have been using it to study for my upcoming test about erosion and weathering.
  I have a project for school involving physics and biking. I believe that there would be plenty of information on Sparticl about those topics.
  I noticed a lot of the things I studied in science listed and I think I will go back there for help.
  The website will definitely help me study for science quizzes and tests.
  It has lots of information that you could use to write a report or an essay. Since I am in eighth grade I am learning about physics with roller coasters and I can come back to where it was talking about roller coasters and how they need certain types of energy at different points in the ride.
  Sparticl seems to be a very good website to help on future science related research projects for school. The videos, games, and articles were very easy to understand and would help me understand concepts in science class easier.
  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.
  It is a very informational site with topics about almost every thing. I am homeschooled right now, and this site counts as credit for my grade. And even when I go to regular school I would use this sit to better understand my subjects.
  I would use Sparticl again if I need to find information about a subject in science, and I need to find reliable sources to gather information on.
  For information and reliable facts on subjects that I may be learning in school; possibly for a resource.
  It can be a good way to find dependable websites for research.
  I can use it as a resource when collecting data for a science project.

- 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.
  Sparticl offers a variety of information concerning a broad spectrum of science related topics. The information I have read about in the last two weeks has been extremely interesting and has taught me so many new things. Such as the history and uses of chocolate, all about Einstein's brain, and dog behavior.
  I find the website interesting, and very informative.
  Whenever I have a general wondering about something and want to go more in depth.
  I did like looking up things that interest me.
  I would return to Sparticl because it had a lot of interesting information and the format for a lot of the topics made it easy to understand it.
  It was setup in a way that was easy to understand, it had information on lots of topics, and it had informational games that make learning fun.

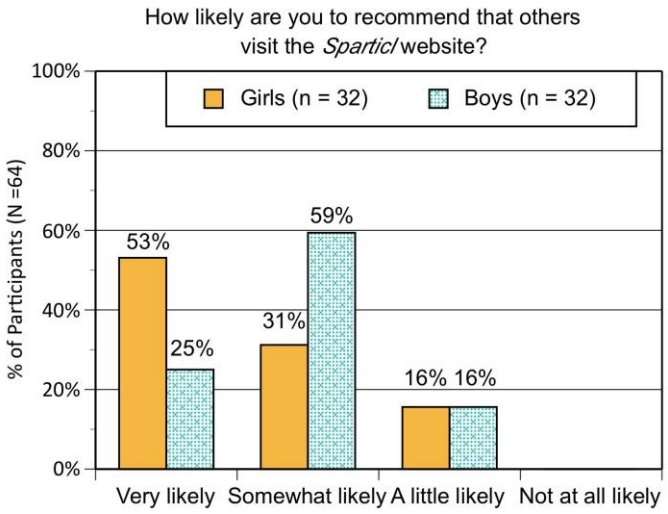
Because I enjoyed being able to explore topics that I'm interested, and I liked how there were different games, videos, and sites.
It explained things that I am interested in and helped me with topics I wasn't.
It is a reliable source of information.
It was an enjoyable way to learn about new things.
There are a lot of good science facts and cool games to play.
I am somewhat likely to return because it was very informative and a good, fun way of learning about different science topics.

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.
Most of the topics were things I already knew a lot about or had little to no interest in, I also don't really see a reason to use it except for maybe finding a website to use for school.
Unless used to get information for school, I would not use it again - it wasn't very fun..
I thought that the articles were good, but I don't usually surf the internet for the types of articles on Sparticl.
Because it's very unlikely that I will need to know about some of the topics
Because I usually don't go to science websites.

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."[11] Girls also were significantly more likely than boys to make such a recommendation (see chart).[12]



[11] χ^2 (2, N = 64) = 15.00, p = 0.0006.

[12] χ^2 (2, N = 64) = 6.03, p = 0.05.

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.

I am very likely to return to Sparticl again because it has lots of useful information to help me with projects or schoolwork. Sometimes when I try to look up a certain topic on Google, it will give me multiple answers, and I don't know which one is correct. Sparticl never makes you second guess your questions and answers.

When you search things, it goes to multiple websites and you can choose one instead of having to look through multiple websites to find one answer. It brings up all the websites that is related to your topic that you searched.

There were many useful resources, and it acted like a mix of a search engine such as Google by taking you to cool new websites, and at the same time had its own information.

I put random things in the search bar and it came up with all of the exact stuff. Like the solar system, and I put in bandaids and they had how bandaids were made and I thought that was so fascinating.

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?"

The only problem is compared to a Google search, you can't really get a specific thing you are searching for because there is not nearly as much content. So when I was looking up mold, I could not find anything about common mold that appears on bread.

It was hard, due to a small number of links, to find something specific compared with a regular Google search.

I'll just Google it and find the real website.

SHARING *SPARTICL* EXPERIENCES

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. And then I talked about the hybrids and ligers with a few of my family.

…13 year old Pacific Islander Male, after using Sparticl

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.

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.[13]

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.[14]

Our participants shared a range of content as illustrated below:

I told my friends about the band-aids and how they make them and how many they make. They make so many a year. And my friends thought that was kinda cool and they also thought I was kind of a nerd. And I also 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.

[13] 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.

[14] t (15) = 2.73, p = .008; mean categories = 5.2 vs. 4.3

I told my friends that some of the Olympics and sports videos were explaining everything that happened, how cool they were because they gave you a background on everything that was happening and you understood how difficult it is.

I showed some of my friends in my science class the website. Like we were reading some of the articles in science class. We had a free work day, so we were reading some of the articles and taking some of the quizzes and things.

I think I shared stuff with my mom about the brain and weather phenomena like tornadoes or hurricanes or earthquakes and about the human body, like what makes teenager's brain different from the adult brain.

I talked to my Mom and my sister about the science of fireworks and roller-coasters and hemophilia.

My family liked to watch the videos with me. Some about alligators and octopuses, my mom thought the octopus video was really neat because they can camouflage and make it look exactly like the setting. We really liked doing it. We will probably keep doing it.

Yah, I did with my family. I discussed life cycle, and I basically told them because they didn't know this: that babies who eat solids too early seem to be subject to allergies later in life.

I was looking up the cracking the code of DNA. That was really cool! Just like how much effort it took and how much time. I told my Mom about it.

I saw this cool thing about a bike frame that was really light. I told my mom about that.

I might have said some stuff about chocolate to my sisters.

I told my brother about this article where NFL players have to take this test and kind of gave a sample from the test. And I made him take it. It's like a generic academic test, like math and English that they have to take.

I did a lot with my little brother. He is in 5th grade. We looked at a lot of the Rube Goldberg machines and the implosions and dark matter.

My brother watched the color blindness video with me.

I have a few friends who are interested in makeup and stuff like that, so I was telling them about that.

Me and my friends were talking about space at one point, so I was talking about how there's this great power and how the black holes, how not even light escapes. And how it even forms, and it's really incredible. And then somebody got a brain freeze, and I was able to explain how that happens, so that was kind of cool, that I was able to explain that after I read about brain freezes. Again, on Sparticl.

I talked to my science teacher about it because on the website they were talking about cells and that's what we are learning about in school.

My science teacher, we were learning a lot of what we were doing in school. I saw a lot of it on the website. I told my teacher about it.

I talked about it with my friends and I told them how it can help us with our research projects and stuff. And I told my science teacher about it.

I told it to one of my teachers. I said I found this interesting website that she might want to share with the class. It's called Sparticl and it has a lot of information on it and interactive games and videos.

AWARENESS OF *SPARTICL* SPONSOR

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.

Company	Never heard of	Company cares not at all	Company cares a little	Company cares somewhat	Company cares a lot
3M	65%/49%	6%/2%	5%/5%	14%/11%	10%/33%
Bayer	63%/62%	8%/5%	11%/11%	11%/10%	6%/13%
Verizon	2%/1%	17%/16%	40%/25%	30%/38%	11%/19%
Toyota	2%/2%	16%14%	37%27%	35%/37%	11%/21%
Boeing[15]	46%/43%	2%/5%	6%/5%	13%/14%	33%/33%

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.*[16] 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]

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.

Company	Helped make *Sparticl*
3M	53%
Verizon	33%
Boeing	33%
Toyota	25%
Bayer	9%

[15] 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.

[16] McNemar Test of Paired Proportions tests the equality of proportions in the pre-survey compared with the post-survey; two-tailed $p = .009$

[17] χ^2 (9, N = 21) = 16.72, p = 0.05.

IMPACT ON INTEREST IN STEM JOBS OR CAREERS

On each of the websites, there were usually like biographies, so I could see that there was 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 our 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*.[18] Looking at individual changes in interest, 69% of the teens 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.

Interest in a STEM job/career	Pre	Post
Very interested	25%	34%
Somewhat interested	48%	41%
A little interested	19%	23%
Not at all interested	8%	2%

[18] Wilcoxon matched-pairs signed ranks, $N = 64$, $z = 1.93$, $p = .03$, one-tailed.

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 the teens, mostly boys, could not describe learning anything from *Sparticl* about STEM jobs or careers, although some of this group had viewed Profiles on the site. 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:
  I learned that there are a lot of different fields you could go into and a lot of different jobs in those fields. There are lots of topics you could work on.
  I learned there's multiple jobs for science.
  There's a lot of them to choose from so you can find one that's you're really interested in.
  Lots of different kinds of jobs. I guess being a scientist doesn't just mean one thing.
  I learned that there's lots of different jobs that have to do with science that I wouldn't have thought that they have to do with science.
  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.
  I guess there is a lot more than I had initially thought. The people who study all the things on there [Sparticl]*. I didn't realize how much of it was all science.*

- 28% recalled learning about **specific jobs or careers;** for example:
  I learned that there are people whose entire job is theorizing about theories. I didn't know that was a job but apparently it is. That's really pretty cool.
  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 learned that people research concussions, and that research is a job – research in different kinds of things.
  I definitely like meteorology more. The job has a lot more meaning to me now. We all think the weatherman always gets things wrong but they actually put a lot of work into it, and it is really hard to find some of the things.
  There was a company that I saw that essentially just made Rube Goldberg machines for various people who asked for them. I found that quite interesting and decided that would be a good job.
  I learned that there is a really broad range of biologists. I didn't know there were so many kinds of biologists, and I thought it was really interesting that each biologist had a very specific part of a specific animal that they studied.
  There is a big variety that all relate to technology and engineering and science. They all have their certain little categories that they work on and that can break down to be more and more specific. There was a type of marine biologist that works with dolphins and tests

how smart the dolphins are. There was this brain biologist except he was working with octopuses and kettlefish and squid and seeing why their brains were so powerful.

I learned that there's different types. Before I thought that if you were going to do something that was involved with space, the job you could get with that was just to go up in space. But it can be the suits that they wear, and things that they use to live in space, and you can direct them while they are in space.

IMPACT ON LEARNING

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

All teens recalled learning 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 content 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.

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. For each content category, topic recall was higher from those who were exposed to more resources in the category. Categories of Earth & Space and Body & Brain were the most memorable overall, and girls reported more from Body & Brain and Living Things than boys did.

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%). Recall of facts or causes was not significantly related to types of resources (text, video etc) viewed or number of resource questions answered.

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.[19] Participants frequently noted black holes, climate change, hurricanes, various planets, and tornadoes. Of those who recalled topics in this category:

- 28% recalled specific **facts**; for example:
  I always thought that Pluto had one moon. I learned that it actually has more than one moon. It is really big, like half the size of Pluto, which is not that big I guess, but still I thought that was pretty cool.
  I specifically recall learning about diamonds – there is a place in I think Oklahoma, I think, that they'll never run out of diamonds because it's over a volcanic crater.
  I learned that Neptune and Uranus are said to create diamond rainstorms.

- 25% reported about **causes, relationships, or processes**; for example:
  Tsunamis are caused by earthquakes under the ocean, and they cause waves to form and cause a lot of destruction.
  …about black holes and how their mass is constant when it gets transformed from a star to a black hole.
  I learned that the reason any species at all is living in the deep sea is because of volcanic vents that are down there….Those are providing nutrients and warmth for species that live in the deep sea.

- 23% of teens simply listed **names** of topics they experienced; for example:
  I was really interested when I was learning about space, when I read about black holes. I thought that was really interesting.
  I learned about geysers. I learned about rock formations, and I learned about minerals.
  In astronomy were black holes, wormholes, solar storms, space tornadoes. I looked at lots in there.

[19] t (50) = 2.98, $p \leq .004$

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.[20] Additionally, girls were significantly more likely than boys to recall specifics from this category,[21] possibly because girls opened significantly more resources in this category.[22] Participants frequently mentioned resources about chocolate, color blindness and the brain (brain freeze, concussions, Einstein's brain, teenage brain). Of those who opened resources in this category:

- 29% recalled specific **facts**; for example:
  I watched this thing on Einstein's brain, and they showed what was different about his and why he is so smart. There is a part of his brain that is 15% larger than the average person.
  I learned about brain freezes, which is a form of headache. I also learned about the body; it can withstand certain amounts of temperature.
  I learned about color blindness. I didn't know that it wasn't just seeing in black and white. It is that you see different colors in a different way than other people.

- 21% reported about **causes, relationships, or processes**; for example:
  I read in depth on the history and making of chocolate, about the different parts of the taste system …I learned about new tastes that we have that not that many people can recognize and …we have umami glands all through our digestive system, so it's almost that we are tasting the entire way down our stomach as the food goes. It's actually pretty neat!
  There was a video. They tested how extreme conditions affect a person's activity. They tested a marine, put him in a big tank of ice water ….he actually did better under the conditions of stress and hypothermia conditions…the lesson was that extreme conditions can improve a person's stamina, reflex, improve ability to run faster, be stronger, and shoot better.
  There was one thing about concussions….about the nervous system, about how your brain sends messages all throughout your body to make your body move.

- 19% of teens just listed **names** of topics they experienced; for example:
  I learned about the skeletal system and the names of some of the bones. And hemophilia, that was interesting..
  I learned some about genetics. I can't name anything in particular but I looked at that a lot. I thought that was interesting.
  I looked at they health and medicine and the human body parts, and I looked at the sight and hearing part and some of the brain part and the brain freeze. And bacteria, concussions and stuff.

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[20] t (38) = 4.47, $p \leq .0001$

[21] χ^2 (2, N = 52) = 7.125, p = 0.03.

[22] t(55) = 3.33, p = .002.

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 were exposed to significantly more Matter & Energy resources than the other half (48%) who did not recall such content.[23] Frequent topics mentioned included fireworks, makeup chemistry, science of various sports, and roller coaster energies. Of those who looked at Matter & Energy resources:

- 32% listed **names** of topics they saw; for example:
  I learned that there is lots of different kinds of chemistry, like food chemistry – that was really fun – and makeup fun.
  How they make fireworks.
  Fireworks. I love fireworks so that was really cool..

- 13% reported about **causes, relationships, or processes**; for example:
  For inertia, I found it interesting that when you put a ring on the top of the jar with a marker on the ring and when you pull the ring out from under the marker as fast as you can, the marker drops right into the jar.
  I learned a lot about kinetic and potential energy in a roller coaster. How at the top of most hills, they have more potential energy, and then they lose the potential energy, and it increases the kinetic energy, and then their - the dead energy - slowly increases as it travels throughout.
  If an airplane has less drag, there's more chance the plane will fly faster and with less resistance than a plane with more drag.

- 8% recalled **facts**; for example:
  I learned there are multiple electromagnetic waves (microwaves, gamma waves, IR waves, etc), and they all make up the electromagnetic spectrum. They can come from cell phones, x-rays, and TV rays.
  That neon was discovered through a study on liquefied air.
  I did not know that gallium was one that could melt at room temperature. I thought that was pretty cool. I learned that silver has higher conductivity than gold. I always thought gold had the highest.

[23] t (51) = 2.39, p = .02

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.*[24] Additionally, girls were significantly more likely than boys to recall specifics from this category.[25] Participants most frequently talked about reindeer, dolphins, cats, dogs, hedgehogs, and plants. Of those who recalled topics:

- 24% of teens listed **names** of topics they experienced; for example:
  Octopi, those are cool.
  I watched these two videos on different breeds of dogs and cats.
  I was looking at proteins and single-celled organisms and stuff like that. It was very interesting.

- 20% provided **facts**; for example:
  Reindeers' eyes change color with the season. I never knew that.
  I looked up a little bit about different types of animals. Snakes and cats are my favorite animals. I learned how toxoplasmosis can travel from host to host.
  I have a pet hedgehog….I learned a little more about them, like salmonella and how hedgehogs can contain that and so usually you have to wash your hands after you play with them. What they eat: because we feed him cat food, but I didn't know they can also eat insects. I learned something new about those, and I thought that was really cool.

- 10% reported about **causes, relationships, or processes**; for example:
  I researched foxes. I found out that they don't form packs, and I thought they did. They make many different sounds for different actions, and the sounds that they make cause them to be mistaken for other animals. One animal that they are mistaken for is an owl.
  I learned about how the plants get pollen from bees that helps it reproduce. And of different parts of flowers, they transport pollen grains to each other, and they can help grow new flowers and help produce new types of plants.
  I learned a lot about dog related behaviors. It was very, very cool. I was able to learn a lot about how certain breeds are bred specifically for certain traits that they have and the way they behave can be related to what they were bred for and how some species are bred specifically for intellectual purposes…

[24] t (37) = 3.87, p = .0004
[25] χ^2 (2, N = 59) = 5.67, p = 0.05.

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.[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*.[27] Participants most frequently noted airplanes, building demolition, microchips, and Rube Goldberg machines. Of those who recalled topics:

- 25% of teens listed **names** of topics they experienced; for example:
  I looked up how computers were made.
  I learned about demolitions and bridges and a lot of cool things too.
  I watched quite a few videos on Rube Goldberg machines, which were quite interesting. I learned about circuit boards under the computer section. I watched a couple videos on that, that was certainly interesting. I learned about planes and aerodynamics and sort of the general idea behind them under engineering.

- 12% provided **facts**; for example:
  The Internet: most kids spend sometimes 10 hours a day on it, and they don't get much exercise.
  I learned that for semi-conductors, I think it was, that they had to use worm skin or something like that in between the layers of the chip.
  I learned that with engineering, there's a bunch of nano. They can create things on a nano level, which is really, really small.

- 11% reported about **causes, relationships, or processes**; for example:
  There are different ways to make buildings collapse on themselves. There is a very small handful of companies who will actually try for skyscrapers in cities to make them fall on themselves. Usually they tie explosives so they fall on its side, but sometimes when space is limited, it has to fall directly on its own footprint.
  I learned how cell phones work. I was still a little confused afterwards, but I mostly learned what affects cell phones and how cell phones work. A cell phone is more or less like a radio, a form of radio that you can communicate to and from both ways.
  I saw this little video from TED that talked about this new camera that could possibly see through walls by using light.

[26] t (42) = 2.35, p = .02.

[27] Pre χ^2 (3, N = 57) = 12.73, p = 0.005. Post χ^2 (3, N = 57) = 8.21, p = 0.04.

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:
    It is an explanation for how things work throughout the entire universe.
    Science is what we know...it is what we know about our world and everything in it.
    How everything works, why it works and how it works.
  - Science is system of acquiring knowledge: a way, method, process of study, research, exploration, figuring out:
    Science is experiments and how the Earth works through experiments.
    A way to figure out things that you don't know about and would want to know about.
    The logical exploration of the world through observations that can be proven and replicated.
  - Science has many fields of study*:*
    There's just all different kinds of sciences.
    It can be about plants, animals, the earth, how chemicals work, and how people work and do different things, how your body can do different things.
    You can study a bunch of different things like rocks, geology, meteorology, astronomy, and the study of space and stuff.

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].

Category: Science is a body of knowledge resulting from systematic study		Post *Sparticl*	
		Category Present	Category Absent
Pre *Sparticl*	Category Present	78%	6%
	Category Absent	11%	5%

- **Category: Science is important:**
  - Science is applied to human needs: useful, helpful, creative, contributes to society:
    Science can be how we create new things, more efficient ways of doing everyday work.
    A way of advancing our civilization and culture to help people and future generations.
    It makes your life easier and it advances society.
  - Science makes up everything, is everywhere:
    Science is in everyday life, nature, living organisms, the world around us.
    Science is all around you. Science is pretty much everywhere.
    Science just makes up everything.
  - People should know/learn science; it's fun, interesting:
    It's very interesting and fun to be a part of.
    It's a really big subject that all people should know a lot about.
    It's important that everyone knows at least a little science.

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 after their *Spartic*l experience increased significantly, with 25% of the teens adding that science is important to their definition of science.[28]

Category: Science is important		Post *Spartic*l	
		Category Present	Category Absent
Pre *Spartic*l	Category Present	34%	5%
	Category Absent	25%	36%

[28] McNemar Test of Paired Proportions, $p = .006$

IMPACT ON SCIENCE CURIOSITY

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 Spartic*l *resources*

Exposure to *Spartic*l 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 *Spartic*l 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 *Spartic*l, 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 *Spartic*l resources were not listed as curiosities prior to using *Spartic*l 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 *Spartic*l 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 *Spartic*l 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:

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

- 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:

Sentence stem	Pre Response	Post Response
I wonder what causes…	*…the redness associated with sunsets/sunrises.*	*…ice to be so slippery, even though it is a solid.*
I would like to experiment with…	*…physics related topics.*	*…different varieties of chocolate making and uses for chocolate.*
I would like to search for answers to questions about…	*…animal behaviors.*	*…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.*

Also after exposure to *Sparticl*, teens' interest ratings (shown in the table below) increased significantly in the topics they proposed for two of the sentence stems (*I wonder what causes…,*[29] and *I would like to experiment with..*[30]) but did not change significantly for the third sentence stem (*I would like to search…*).

Interest in finding cause, experimenting with, and searching for	***I wonder what causes…***		***I would like to experiment with…***		***I would like to search for answers to questions about…***	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Very interested	38%	49%	55%	61%	50%	54%
Somewhat interested	54%	46%	38%	34%	42%	43%
A little interested	6%	5%	8%	5%	8%	3%
Not at all interested	2%					

[29] χ^2 (6, N = 63) = 34.11, $p \leq 0.0001$.
[30] χ^2 (4, N = 64) = 20.11, $p \leq 0.0005$.

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.[31] 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.* [32] Pre and post mean ratings for each statement are shown in the table on the next page.

[31] 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.

[32] 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	Strongly Disagree =1	Disagree =2	Undecided = 3	Agree = 4	Strongly Agree = 5
It is important to know science in order to get a good job. (significant change)	Pre mean = 3.41 Post mean = 3.64				
Most people should study some science. (significant change)	Pre mean = 4.14 Post mean = 4.33				
Science is useful in helping to solve the problems of everyday life. (significant change)	Pre mean = 4.20 Post mean = 4.44				
Science is of great importance to a country's development.	Pre mean = 4.42 Post mean = 4.39				
Science is helpful in understanding today's world.	Pre mean = 4.56 Post mean = 4.64				

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 with pre and post interview excerpts. The percentages of responses falling into 5 of the 7 themes increased from pre to post interviews, although not significantly. However, 38% of post-*Sparticl* responses included a specific example from a *Sparticl* resource.

- **Engineering is valuable for transportation and building**:
  Pre = 42%; Post = 45%
  Pre:
  Engineering really helps us with cars and helping us get around.
  Engineering helps us build cars…transport good, move around and get to where we need to go.
  Engineering is really valuable to our society because engineers can build bridges or buildings…Humans could use engineering to make people move to other planets.
  Post:
  Cars are created with engineering. Airplanes, rockets, different kinds of motor cycles and bikes.
  I looked at this one about a hydraulic bike that is being invented…
  When I was researching about bridges: How they were discovering new technologies to put sensors on bridges so that they can detect certain flaws in the structures of the bridges, so they could fix it before anything bad happened.

- **Science is valuable for understanding the world, solving problems**:
  Pre = 36%; Post = 42%
  Pre:
  It's important for us to realize why things happen and why they happen the way they do.
  It's important to know how to solve problems that have to do with science, and it's important to know how things work so you can solve issues. …

It explains how things work and it gives you a greater understanding, and you can do your job better with a greater understanding of how things work.

Post:

I just think of motion and stuff, and science helps you understand how that works, like Newton's laws.

Learning about how things work and how you solve issues that related to them. To solve problems, you need to figure out how things work, and that's what science teaches us.

It's valuable because it helps people actually understand things. A society when people just are taught things but don't understand what the topic is does not work. …because when people understand how things work, they could be smarter about their choices and decisions they make with their life.

- **Science, technology, or engineering is valuable in medicine:**

  Pre = 26%; Post = 31%

  Pre:

  In the medical field, it is better and more accurate in results, and you can do it faster than you used to be able to.

  The advancements in medical technology has helped cure diseases, have allowed us to detect diseases and treat them earlier and more thoroughly.

  With medicine, our life expectancy has gone up. We live longer, healthier lives, and science is to thank for that.

  Post:

  Through science, they know chocolate is beneficial, and so people don't have to feel bad when they eat it, so that's beneficial to society.

  How doctors help with vaccinations. How vaccinations work – sometimes it's like putting the illness into you and having your body fight it.

  There's an article on the Sparticl website about cloning and 3D printing. I learned that there's been new technology that allows doctors to print organs for patients who don't have proper organs and they need one…You can actually 3D print functional organs…

- **Science, technology, or engineering helps us survive, makes life comfortable**:

  Pre = 20%; Post = 28%

  Pre:

  We really depend on technology. It wasn't so much in the past, but nowadays we depend on technology for everything – work, traveling, even feeding ourselves…

  It's really important because it helps us build machines. Without machines, life would be really hard and that has to do with engineering. That makes everything easier.

  For everyday comfort in our everyday life…When it comes to comfort, it can help with air conditioning; and if you go outside and it's too cold, you can use the heater, which uses science….Science can more or less help bring comfort.

  Post:

  It kinda helps us with a way of life, because we can't really live without mechanical engineering.

If we didn't know how water and water pressure work, we would all die because we couldn't get water.

Science, technology and engineering are valuable to our society in ways that include better devices, easier lives…as in water filtration, central heating, boats, cars, biotechnology and what not.

- **Technology supports easier, faster communication**:
  Pre = 27%; Post = 19%
  Pre:
  With the technology of phones and Internet, it makes communication easier between people, and it makes people be able to communicate faster and more conveniently.
  We can use computers and other technologies to communicate with people that we usually wouldn't be able to.
  You can connect with people really fast instead of writing letters and waiting weeks for a reply.
  Post:
  I looked up cell phones. With cell phones, it helps us communicate with other people not right next to us. It helps us talk to them or text them.
  Our lives have benefited by communication. Without science, communication would be a lot less. We can talk to people across the world and spread culture through communication that was created by science.
  With technology, we can basically talk from across the world. We have phones.

- **Science, technology or engineering helps us understand and solve environmental issues:**
  Pre = 8%; Post = 14%
  Pre:
  …your thermometer…is valuable because it's important to know what's going on with the temperature…Scientists need to know how that varies every day and how that affects what's going on on Earth.
  LED lights are more cost efficient. They also help the environment.
  If you have crops, and you need to put pesticides on them to keep away insects, an engineer would help balance it out.
  Post:
  If we had a problem with pollution, you could look at it through science or engineering, you could figure out ways to reduce it or eliminate it completely.
  For oil spills, you can come up with technologies to clean up oil spills and make sure it doesn't harm wildlife. They can try to figure out how to cap off an oil spill in the sea, or they can use technology to track where it is traveling, and they can see where it has been in the water.
  With different technology, you can find out more about plants and animals and how they work with the world around us, the way that they help you be able to function better and grow healthier.

- **Technology, particularly the Internet, helps transfer knowledge and helps us learn:**
  Pre = 17%; Post = 14%
  Pre:
  Technology helps us transfer knowledge.
  Our society has become much more accessible through the websites we've been able to access knowledge that has been shared throughout the world.
  You're able to go on the Internet, and you can pretty much find any source of information from any database.
  Post:
  …with technology like computers, it gives us a resource for finding information…we can now look on the Internet for schoolwork instead of books. It helps us learn things faster, and it helps us understand things more.
  When I think of advancing society, I think of computers.
  Technology helps us do things faster like search things.

DISCUSSION

Our teens valued *Sparticl* as intended by TPT and 3M 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 *Spartic*l 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 S*partic*l and unusual such as science of chocolate, brain freezes and reindeer eyes. Additionally, teens noted how *Spartic*l 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 *Spartic*l 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 *Spartic*l might affect teens in ways not typically associated with an informational website: As a result of their *Spartic*l 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, *Spartic*l generated in our teens a significant amount of face-to-face sharing of information acquired from the resources. Eight of ten teens shared memorable *Spartic*l 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, our teens did not join in the online *Spartic*l social community of rating, commenting, sharing or recommending resources, despite the fact that 80% of our participants frequently use social media sites like Facebook. This evaluation did not explore teen reactions to the community features of *Spartic*l, 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 *Spartic*l 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. *Spartic*l 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. *Spartic*l's growth as a social STEM community will need to develop further these features.

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