Evaluation of the TV411 "What's Cooking?: Serving Up Math and Science" Program

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May 9, 2013

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OVERVIEW AND HISTORY OF THE PROJECT

In the spring of 2010, EDC (Education Development Center) approached Owen Consulting, Inc., to conduct an evaluation of the content and design of the science components of its TV411 program. TV411 originated as a public television series in the 1990s designed to help adult learners develop skills in reading, writing, and math. Based on its success, TV411 launched its first website in 2002 to accompany the television series. In 2010, EDC received a grant from the National Science Foundation that enabled it to reconstruct the website, produce new science content, including videos and web lessons, improve user interactivity, and develop materials to support adult educators who work with the site's target population of low literacy adults. The goal of this work was to:

1. Improve adults' awareness of how key math and science concepts that they often hear about in the news connect to their lives;
2. Help adults overcome negative attitudes and behaviors about tackling science and math topics that they view as too challenging or too hard to understand;
3. Increase adults' knowledge, vocabulary, and skills related to science and math.
4. Increase the comfort level, understanding, and capacity of adult educators and informal workshop facilitators to teach basic math and science concepts.

Work on the new science curriculum began in October 2010, shortly after the grant was funded. By April 2011, scripts, casting, and a shooting schedule were in place, with video production beginning shortly thereafter. Concurrently, TV411 staff undertook a redesign of the site's look and feel. Working with OpenSourcery, LLC, TV411 put a new Drupal-based content management platform and supporting database into place, and the site went live in March 2012. As development moved forward, TV411 conducted an informal usability assessment with approximately 50 pre-GED/GED learners at adult education sites in New York City. Adjustments were made to the site's architecture, graphics, and interactive elements based on this assessment. Teachers' guides were also created in order to support educators' use of the site.

TV411 is an entirely open site. Users are not required to register or log in to view any of its content. From the TV411 home page, visitors can select from six topics. Those selecting "Science" are taken to the top level TV411 What's Cooking? page (TV411WC) where they select the specific science subject in which they are interested (bacteria, heat, carbohydrates, photosynthesis, salt and water). Each topic has one video and two associated web lessons (one that covers the science content and another focused on the math, e.g., exponentiation, unit conversion, or graph interpretation). Visitors can view the content in any order they choose. For example, a visitor could watch a video on bacteria, complete (or start and not complete) a web lesson on photosynthesis, watch another video on salt, and return to watch a video on photosynthesis. While visitors who register and log in can track their progress through the site's content, there is no requirement that content must be experienced in a particular order.

All of the science content was created around a cooking theme, and indeed, each video begins with the tagline, "Some of the key ingredients in any culinary creation are a pinch of science and a dash of math."

The videos, which average eight and a half minutes in length, mix the preparation of an actual recipe with the science and math content and employ a variety of instructional techniques, including graphs, on-screen text, animations, and dialogs, to get their messages across. More than simply reviewing what is presented in the videos, the web lessons build out from them and add to users' experience. They included a variety of different interactive elements—multiple choice, drag and drop, checklist, sequencing, fill in the blank, and open writing questions—and utilized a range of graphical and animation elements. Users can advance through each element of a web lesson regardless of whether they perform the interactive task successfully or not, although they are given feedback if they are unsuccessful.

The report that follows lays out the evaluation design (and the changes we made to it), provides an overview of site web metrics (click throughs, etc.), describes the registered user population, discusses the ways in which the site has been employed in an informal science education setting (a nutrition program for the parents of Head Start participants), and outlines key project outcomes around learner engagement (based on our own observations, data collected about registered users, and web analytics), the acquisition of content knowledge, and the Head Start implementation. We conclude with a summary and set of recommendations for the National Science Foundation and the project staff.

RESEARCH DESIGN

Evaluation Plan

Our overall evaluation approach was designed to assess both informal online and informal and formal classroom impact and implementation of the TV411WC program. While primarily focused on an assessment of impact outcomes, the study was designed to examine process as well. In addition to answering questions about whether the curriculum worked, we sought to learn how it worked, for which learners, and under what circumstances. Based on the four outcome goals specified above, we were interested in assessing:

- Visitors' awareness and understanding of science and math concepts
- Their engagement or interest in science and math subjects
- Their attitudes towards science and math related topics
- Their attitudes and beliefs about their own ability to learn science and math
- Whether instructors in informal educational settings could be supported to use the TV411 videos and how such use would unfold in their classrooms

Central to our focus therefore was the development of an understanding of how learners (in the online setting) and instructors (in the on-the-ground settings) use the videos and materials to learn and/or teach STEM content.

Evaluation Challenges

Central to our evaluation of the online component was an assessment of changes in visitors' knowledge of the science content presented on the site and their attitudes toward science in their lives—their levels of confidence with science and math as academic subjects and their understanding of its relevance. The

assessment of knowledge was to have been based on the unobtrusive presentation of a series of content knowledge tests (CKTs) to visitors as they interacted with different components of the site. As we described, TV411WC visitors are able to interact with the site in a variety of different ways. In each of the six subject areas covered by the site for example, visitors can choose to simply watch the video, complete a single web lesson, complete multiple web lessons, or watch the video and complete one or more web lessons. Moreover, the different components can be experienced in a single session or over multiple sessions spread over several days, weeks or months. The original evaluation design took advantage of this situation by viewing the number of components experienced prior to the CKT as a proxy for dosage. According to our plan, the system was to have been set up to randomly present the CKTs to a sample of visitors and to collect, along with their scores, the date and time at which the CKT was completed. Because all visitor interactions (e.g., advancing to a web lesson, completing a video, etc.) are time- and date-stamped, it would have been possible to determine which site features were experienced prior to administration of each CKT. Our hope was to be able to place visitors into various "bins" based on dosage prior to the CKT and then compare CKT outcomes across dosage categories using analysis of variance procedures. In addition to dosage, we had planned to examine how different groups of visitors responded to their TV411WC experience by including a number of sub-group comparisons in our analysis.

For a variety of technical reasons, the random appearance of the CKTs proved too difficult for the site's developers to implement. In order to address this issue we decided to fall back to a system in which the position of the CKTs would be manually rotated such that they would be presented at various points in each subject module over the course of several months. With a sufficient number of visitors, we were confident we would be able to fill the aforementioned "bins" with enough cases for a robust statistical analysis. As in our original design, this plan required the use of the site's built-in system for creating time stamps that capture visitor interaction with the online content. In order to be of any use however, these time stamps had to be sequenced by visitor, something that required visitors to register on the site and consistently login each time they visit. Because most visitors did not register, this did not occur. In lieu of the "natural" experiment we had planned, it therefore became necessary to administer the CKTs in controlled settings with pre-selected groups of adult learners who fell into the project's target group (adult learners with less than a GED degree). Working through contacts established with adult education programs in New York City, TV411 staff walked learners through the registration process and guided them through the various dosage trials. In addition, other teachers in Durham, North Carolina and elsewhere were encouraged to ask their students to register on the site. Some of these groups were presented with CKTs prior to any interaction with the site, others got CKTs after only watching the videos, and so forth (the number of learners in each trial is detailed in the analysis section). While this approach made it possible to go forward with the basic analysis we proposed, it did not provide a sufficient number of cases to analyze all the science content areas individually, to compare across as wide a range of dosages, or to make demographic comparisons.

In order to assess visitors' attitudes and behaviors (items III and IV above), the evaluation design called for a pre- and post-survey of attitudes towards science and math. The survey included items assessing

science and math confidence and beliefs about the relevance of science and math knowledge to learners' personal lives and their lives as citizens in a technological society. The survey was administered as a pre-test (that is, prior to visitors' engagement with the site) to users who registered with the system between November 2012 and March 2013. Along with their registration confirmation email, they received a link to the online survey, which was hosted separately. In order to boost response rate, users were offered the chance to participate in a raffle for an Apple iPad. Subsequently, emails went out to visitors who had completed the pre-test survey, requesting that they log in and interact with the science content. In this instance, recipients were told that if they visited the site and completed a follow-up survey, they would be eligible to receive a $25 Amazon gift card. Unfortunately, only nine responded to the post-test survey invitation, and for that reason, it was not possible to conduct the pre-post analysis as we had planned.

As challenging as they were, these difficulties did present us with an opportunity that was not part of the initial evaluation plan. Because some of the administration of the CKTs was done in person, the Owen Consulting team was able to interact with and observe learners as they went through the videos and web lessons. More than that, we were able to conduct a series of focused discussions with the pre-GED participants who made up the test group, and from these learned a good deal about how they interact with web based content, what they value about it, and the kinds of challenges they faced with it.

Finally, based on concerns we had about their interpretability, we significantly scaled back our analysis of the web analytics data. Given the different ways in which this population of adult learners interacts with the Internet, we were wary of making inferences based on data more representative of the computer accessing the site than the individual sitting before it. That said, we do report trends in page views because they are indicative of the site's ability to engage visitors.

TV411 IN ACTION: OBSERVATIONS AND DISCUSSIONS WITH THE ADULT LEARNERS

Owen Consulting participated in four focused discussions with learners at the Mid-Manhattan Adult Learning Center (MMALC) and reviewed notes taken by TV411 staff at this and other sites in the New York area. MMALC is operated by the New York City Department of Education and offers GED, pre-GED, and other classes to adults from throughout the city. The classes we observed were all part of MMALC's GED program. There were on average about 20 students in each class, including both young adults and people in their 40s and 50s. Several were recent immigrants to the United States. Three of these sessions were large group discussions, and one was a formally constituted focus group in which participants created a brochure for the program designed to highlight its features for prospective students.

The participants with whom we spoke varied in their views about the difficulty of the TV411 science content. No one told us it was too easy, nor did anyone indicate that it was too hard. Overall, it was clear that they found the TV411WC videos accessible and engaging. TV411WC's strategy of building the program around cooking was a wise one. Participants told us that they viewed cooking as an activity that brings people together, and for this reason, we believe it was positively valenced for them and therefore likely to attract their interest. We noticed several participants taking notes as the videos played, and in

the follow-up discussion, we learned that they found in them numerous touch points. For example, several told us that they now understood their culture's use of salt as a preservative. Another person noted that the video, in particular the fact that a live person was on screen, helped "orient" her to the content of the module and therefore served as an excellent introduction to what that module covered. The videos were also successful in communicating the idea that science and math are related and that both are related to cooking. As one participant told us, "It wasn't too complicated. I learned that science goes with math and math can't go without science."

The web lessons were also viewed positively, although differences in learners' levels of preparation affected their ability to navigate through the content. We heard repeatedly how much participants liked the feedback they got after each web lesson question: "I liked that when you answered correctly, it gave you the definition, but if you were wrong, you didn't have to re-read everything…. you got enough of a hint so that you could get it right on the second try." Someone else told us:

> I liked that it tested your mind, it lets you know what you're really studied, what you know….sometimes it's good to get an answer wrong because you take notice of it and then you go back to check it and it stays with you.

Another said, "In the beginning, it was a little bit intimidating, but once you started reading, they gave you the information, so you just had to concentrate." Someone else said, "I liked them [the web lessons]. At first I didn't get it, but then I just started getting into it, I relaxed and it became fun." It was clear that for at least some participants, viewing the video prior to the associated web lessons was an important part of their overall experience: "It was easy, she [the video's host] explained everything, yogurt, bacteria… .we didn't have to assume anything." Participants who viewed the video prior to the web lesson seemed to have less difficulty, although there was nothing in our evaluation design that systematically captured data to adequately support this belief.

Although learners' responses to our questions indicated that the TV411WC content was appropriately leveled, a number of participants seemed nonetheless to struggle with it. Our overall sense in this regard was that the challenges for these students centered on computer literacy and reading fluency. Some participants read very hesitantly, for example using the cursor to move from word to word in the explanatory text provided in the web lessons. We observed another participant struggling for over five minutes with this written material. For some of these readers, the density of this text could prove to be a hindrance when viewing the site. Others faced challenges due to their limited computer skills. Several did not understand how to scroll down the page to view "below the fold" content. Others did not understand how to use the mouse to interact with the questions presented in the web lessons. TV411 staff members are aware of these issues, and we understand that the site was not at all intended to teach basic computer literacy. That said, institutions adopting the program need to know that its use requires certain basic computer and reading fluency skills to be effective.

In addition to advising visitors of the kinds of computer skills required to use its system, we believe that TV411WC can make a number of improvements to website usability that may offset some of the issues visitors faced. Foremost among these would be to consider strategies for sizing the content so that it

appears on a single screen. We observed several students who were unsure about what to do after reading a screen-full of content. In one instance, a learner who answered a question incorrectly failed to see the hint text because it was shown below the displayed area. Another failed to notice the "tips" section for the same reason. We realize that balancing readability (comprehension), legibility (decoding), and usability is extremely challenging and that each may be in conflict with the others (for example, legibility might be improved by increasing font sizes, but this would send more content below the fold). That said, we believe it would be worthwhile for the site's designers to undertake a formal study in order to see where and how usability might be improved. Overall, however, participants viewed the site as something that would be very helpful to someone preparing for the GED exam. They enjoyed the "visual learning" aspects of the site, felt that it made learning accessible and fun, and appreciated the fact that it was free.

TV411 IN AN INFORMAL ADULT EDUCATION SETTING

One goal of the TV411WC project was to learn how it might be used in an informal adult education setting. In order to answer questions around this issue, project staff developed a relationship with Cornell Cooperative Extension (CCE), which offers a food safety and nutrition program to parents of children enrolled in Head Start programs in New York City. CCE Community Nutrition Educators presented one or more of the six TV411WC videos and encouraged students to visit the site at home with their families. Owen Consulting observed five CCE Head Start classes (both English and Spanish), interviewed four Community Nutrition Educators (CNEs), and reviewed observation notes prepared by TV411 staff. The purpose of these activities was to assess how informal adult educators utilized the TV411 materials and how learners responded to them.

The CNEs we observed and interviewed incorporated the following videos into their lessons: bacteria, water, salt, carbohydrates, and heat. Some centered the entire class session around a video, choosing not to associate it with a specific nutrition lesson. Another asked her students to select videos for viewing. Most, however, integrated the videos into their nutrition lessons as suggested in the training they received from CCE. It was clear from the interviews that the CNEs were enthusiastic about the videos and would use them again. They reported that the recipes were appealing, well presented, and easy to prepare with readily available ingredients. The CNEs valued the way in which they supported the messages about food safety, the "hows and whys" of reading food labels, the importance of drinking plenty of water, and, more generally, the benefits of improved dietary behavior that they were trying to impart to class participants. As one educator told us, "It's a wonderful way of reinforcing the information [we're trying to present]. You're looking at the math and science components and then you have a recipe." Another mentioned using the salt video to teach about the importance of reading labels, noting that a message about the salt content of processed food she was trying to get across really hit home after watching the video. Another told us,

> You can't teach this [nutrition curriculum] without measurements and science. What I particularly like about TV411WC is that it's so simple to see the math concepts, with the

> visuals, and that's the feedback I've received from participants….It's science but made very simple, and it's fun.

With regard to the math, two of the CNEs said that the visual presentation of the math helps them teach math concepts. Not all of the teachers explicitly cover math in their lessons, for example, because they believe that their students do not use measurements when they cook.

As part of its work with CCE, TV411 staff created a series of teachers' guides, one for each video, designed to help the CNEs integrate the science into their nutrition lessons (the guides were distributed to the CNEs and are also available for down on the TV411 website). The guides present the science and math vocabulary used in the video; suggest teaching tools that can be incorporated into the lesson (such as a small paper clip and a measuring spoon for the salt video); offer one or more pre-video questions designed to establish comfort with the topic; and discussion questions—along with model answers—to be used after the video. The Teaching Guide packet also includes guidelines on showing the videos, a reminder to encourage visits to the TV411 website, and a glossary of terms used. Three of the four educators we interviewed reported using the guides, a statement supported by our own observations of the program in action. As one CNE told us, "When you are teaching people who are at different levels, it's important to use the right concepts, for example, what happens in cooking if you are using the microwave instead of the stove. The Teacher's Guide gives you the science information, and it gives you a way to explain it to your audience."

While suggestions for the pre-video discussion helped frame the purpose of the videos for the class, the after-video discussion generally focused on food selection, preparation, and safety issues unless the teacher explicitly brought the discussion around to the science. After viewing the bacteria video, for example, we observed students asking about marinating food and other food safety issues. In another class, also on food safety, the instructor referred back to references in the video about the ideal temperature for bacterial growth, although she did not use the mathematical concept of "exponential growth" as presented in the video. In our observations and also in teacher interviews, we learned that a discussion following the salt video included mention of the periodic table and the difference between a compound and an element. Although students' comments reflected a basic understanding of these concepts, we observed some confusion about the relationship between milligrams and grams and the daily recommended amount of sodium, when expressed in these units. As one teacher put it, "Students are more convinced by the visual cue [in the web lesson] that a teaspoon of salt is the daily recommended amount."

Our observations confirmed much of what the teachers told us. Participants found both the cooking and science content entertaining and engaging and were able to connect what they saw in the videos to their own experience. For example, we saw students nod in agreement when information reinforced what they already knew (e.g., that it is a good idea to have two cutting boards in the kitchen to avoid cross-contamination) and noted that they smiled at the humorous exchanges between the host and her guest. Throughout the videos, we heard students express interest verbally as well. In the post-video discussion, some participants focused more on science content while others showed a greater interest in the food and recipe material. In these latter instances, the instructor was able to reorient the discussion in order to

reinforce the science vocabulary. As the lesson shifted to the regular nutrition curriculum, the instructor continued to reference the science covered in the video. We found particularly interesting the ways in which the science and nutrition lessons merged. For example, one participant expressed surprise that fruits and vegetables contain salt. Another was interested in how salt is used to cure and preserve food.

While two of the CNEs reported visiting the TV411 website, it seems to have made less of an impression on them than the videos (unfortunately the lack of web connectivity in the classrooms where the sessions took place meant that participants were unable to view the website during the class). Indeed, in our observations, we noted several instances in which educators neglected to mention the website during the lesson (one admitted during the interview that she herself had not visited it). Another, however, estimated that six of her ten students had visited the site and were enthusiastic about it. Still another reported that one of her students watched the video with her family and reported that they had all enjoyed the experience.

A number of the teachers reported that the videos would work well in other programs they lead. For example, one teacher used the videos with ESL students and said she would use them with a group of grandparents who are caretakers for their grandchildren. The same teacher thought they would be valuable to show with multi-generational groups, including teens, who would take the knowledge back to their communities.

A number of educators had recommendations for improving the support materials provided to them and students. For example, one teacher suggested handouts with the recipes that could be distributed after the class (these were made available at some of the sessions). Another suggested that where appropriate, the information presented in the videos could be summarized graphically on branded materials they could distribute. Examples of this included ideal temperatures under which bacteria thrive or a summary of the food safety issues presented in the bacteria video. In the course of our observations and discussions with the teachers, we also learned that there were occasional technical glitches that prevented them from showing the TV411WC videos. These included the lack of an Internet connection or DVD player or monitor. These challenges may be par for the course given some of the settings in which informal educators work.

It is worth noting that some of the CNEs were not initially comfortable with the science and math content presented in the videos. This should not come as a surprise: In an informal educational setting such as the one described here, there is no expectation that instructors will have much formal background in the subjects covered (we were told by managers at CCE that a high school diploma was the only formal requirement for the role). If they are to adopt the materials, they need to be supported as they learn the underlying content themselves and figure out how to integrate it into their existing curriculum. TV411 staff members were able to provide this support in the form of the teachers' guides it offered. Perhaps most promising, the CNEs who have been introduced to the TV411WC materials are continuing to use them in their current classes, and CCE has used them to train new CNEs with the expectation that they will use them as well.

VISITOR DEMOGRAPHICS

It is important to understand that the findings reported in this section reflect only those of the registered users in the target audience who interacted with the TV411WC content, a group that makes up only a small fraction of the site's visitors. In other words, it is based only on 'science visitors', defined as anyone who registered on the TV411 site and interacted with the science content while logged in. Moreover, it is somewhat biased by the fact that in order to build a response to the CKTs, TV411 staff actively recruited visitors through contacts in the local adult literacy community. These caveats aside, the demographic description presented below represents the only measure of visitors' backgrounds available.

Because of the low number of registered users, the TV411 team expanded the eligibility requirement for participation in the study to include adults with a two-year college degree or less education. As Table 1 shows, however, eighty-nine percent of the science visitors for whom we report demographic data had a high school degree or less.

Education Levels Included in Demographic Analysis

Analysis Group	N	Valid Percent	Cumulative Percent
Some HS or Less	311	68.8	68.8
Completed HS or GED	90	19.9	88.7
Completed some college or Associates degree	51	11.3	100.0
Total	452	100.0	

Table 1

Table 2 shows the gender of registered science users. The distribution into gender categories is equivalent across the three different education levels.

Gender

Gender	N	Valid Percent	Cumulative Percent
Male	138	32.2	32.2
Female	290	67.8	100.0
Total	428	100.0	

Table 2

Table 3 shows responses to an item on the registration page that asked about English fluency. As the table shows, most registered visitors indicated that they spoke English at home. As was the case with gender, there were few differences across the three target groups.

English Fluency

Fluent in English	N	Valid Percent	Cumulative Percent
Yes	354	87.8	87.8
No	49	12.2	100.0
Total	403	100.0	

Table 3

Median age for registered users is given in Table 4 on the following page. Not surprisingly, those who have completed some college work are slightly older.

Median Age

	Median Age
Some HS or Less	35
Completed HS or GED	32
Completed some college or Associates degree	44
Combined	37

Table 4

Visitors were given the option, when registering for the site, to select more than one ethnicity category. In analyzing the data, we ascribed a category "multi-ethnic" to these registrants. They are shown in Table 5.

Reported Ethnicities

	N	Valid Percent	Cumulative Percent
Asian	20	4.5	4.5
Black/African American	220	49.4	53.9
Hispanic/Latino	81	18.2	72.1
Multi-ethnic	29	6.5	78.7
Native American/Alaska Native	10	2.2	80.9
Native Hawaiian/ Pacific Islander	2	.4	81.3
White/European	83	18.7	100.0
Total	445	100.0	

Table 5

Table 6 shows the level of education reported by registered users. As the table shows, nearly seventy percent of users had only completed some high school or had less education prior to visiting the site. As we indicated earlier, however, these figures include a sizeable number of visitors who were explicitly registered through contacts in the adult education community in order to receive the CKTs.

Education

	N	Valid Percent	Cumulative Percent
Some elementary school	26	5.8	5.8
Completed school through grade 8	57	12.6	18.4
Some high school	228	50.4	68.8
Passed the GED	24	5.3	74.1
Completed high school	66	14.6	88.7
Some college	43	9.5	98.2
Completed two-year degree	8	1.8	100.0
Total	452	100.0	

Table 6

ATTITUDES TOWARDS SCIENCE AND MATH

One goal of the TV411WC project was to affect visitors' attitudes towards science and math. Two kinds of attitudes were targeted: the individual visitor's confidence in math and science subjects and attitudes about the relevance of science and math knowledge in their own lives. After a review of the literature, it was decided to develop a scale specifically for the TV411WC evaluation since the extant scales were either specific to a particular STEM subject, designed for learners in formal school settings, or not appropriate for adults in the site's target population. The survey we developed asked respondents to rate their level of agreement with twelve Likert type items that covered these attitudes. Both science and math items were included. Although the lack of response to the post-survey precluded an analysis of attitudinal change, we believe that the pre-test survey provides an interesting picture of the beliefs those who visited the site that is worth reporting. Because there was only minimal variation across groups, the tables below aggregate responses for the three analysis categories described above (visitors with less than some experience in college or less). Where differences between groups were larger, they are noted in the text.

As we described the research design section, registered users were recruited to participate in the survey via an email invitation. Those who completed the pre-test were subsequently invited to view the science content and asked to participate in the post-test (see page 6 for details). Table 7 shows, survey respondents generally reported enjoying science. Nearly ninety-percent expressed a desire to learn more about science and, as the subgroup comparisons revealed, this interest was felt most strongly among those with the lowest levels of educational preparation.

Enjoyment of Science Content

		Percent	N
I would like to learn more about science	Disagree a lot	5%	15
	Disagree a little	6%	17
	Agree a little	27%	81
	Agree a lot	62%	187
Learning about science is enjoyable	Disagree a lot	4%	12
	Disagree a little	13%	38
	Agree a little	31%	94
	Agree a lot	52%	157
I enjoy watching TV shows or reading articles about science	Disagree a lot	8%	25
	Disagree a little	12%	35
	Agree a little	35%	105
	Agree a lot	45%	135

Table 7

Table 8 shows the responses to a series of questions related to respondents' beliefs about the importance of understanding science, both to themselves and to society at large. Over ninety percent of respondents at least somewhat agreed with a series of positive statements about the importance of science (smaller majorities strongly agreed with these statements) and about eighty-percent at least somewhat disagreed

with a negatively worded item (sixty-nine percent strongly disagreed). Again, sub-group comparisons revealed equivalent results.

Importance of Science and Math

		Percent	N
I can see why it is important for me to understand math	Disagree a lot	1%	1
	Disagree a little	2%	3
	Agree a little	17%	31
	Agree a lot	81%	145
It's just not that important for people to understand math	Disagree a lot	72%	128
	Disagree a little	11%	20
	Agree a little	5%	9
	Agree a lot	12%	21
It is personally important to me to understand science	Disagree a lot	1%	1
	Disagree a little	6%	10
	Agree a little	26%	46
	Agree a lot	68%	122
It is important that people today understand a little bit about science	Disagree a lot	2%	3
	Disagree a little	5%	9
	Agree a little	33%	59
	Agree a lot	61%	109
I can see how knowing more about science might be useful in everyday life	Disagree a lot	1%	2
	Disagree a little	6%	11
	Agree a little	30%	54
	Agree a lot	63%	113

Table 8

Although respondents' attitudes towards science and math were generally positive, confidence in their ability to learn and understand science and math concepts was mixed and varied with their level of education. Some of the findings from this set of items were contradictory as well. For example, ninety-four percent (74% plus 20%) indicated that they at least somewhat agreed with the statement "I am confident that I can learn math," yet only fifty-three percent (34% plus 19%) at least disagreed a little that they were not "the type of person who can do well in math." In other words, while a very large percentage of respondents were confident in their math abilities, a bare majority did not disagree that they could not do well in math. Moreover, a higher percentage (65%) of those in the more educated group (those with some experience in college) tended to a least disagree a little with the negatively worded statement (compared to 53% for the middle group and 49% for the least educated group) indicating more confidence, whereas slightly fewer of the most educated group (89%) tended to either agree a lot or agree a little with the positively worded statement (compared to 95% and 94% respectively for the less educated groups). Results from the two statements about science were similarly mixed. All these results are displayed in Table 9 below.

Confidence in Science and Math

		Some HS or Less		HS or GED		Some college		Total	
		Percent	N	Percent	N	Percent	N	Percent	N
I am confident that I can learn math	Disagree a lot	2%	4	3%	2	2%	1	2%	7
	Disagree a little	3%	6	2%	1	9%	5	4%	12
	Agree a little	21%	37	25%	16	14%	8	20%	61
	Agree a lot	74%	133	71%	46	75%	43	74%	222
I am not the type of person who can do well in math	Disagree a lot	28%	49	34%	22	53%	30	34%	101
	Disagree a little	21%	38	19%	12	12%	7	19%	57
	Agree a little	29%	51	31%	20	21%	12	28%	83
	Agree a lot	22%	39	16%	10	14%	8	19%	57
Science is just too difficult for me to understand	Disagree a lot	26%	47	30%	19	56%	32	33%	98
	Disagree a little	28%	51	31%	20	28%	16	29%	87
	Agree a little	32%	57	28%	18	12%	7	27%	82
	Agree a lot	13%	24	11%	7	4%	2	11%	33
I get stressed out when I think about having to learn about science	Disagree a lot	32%	58	33%	21	36%	20	33%	99
	Disagree a little	27%	48	30%	19	22%	12	27%	79
	Agree a little	31%	56	25%	16	27%	15	29%	87
	Agree a lot	9%	17	13%	8	15%	8	11%	33

Table 9

The mixed results on the four confidence items aside, we believe that the findings from the attitudinal survey indicate that adult learners view science and math as important subjects and that under the right conditions they enjoy learning about them.

ACTIVITY COMPLETIONS

As we have noted, each of the six science subjects covered by TV411WC included one science web lesson and one math web lesson. These web lessons consisted of either three or four activities, and each activity was, in turn, made up of between three and ten individual questions (the number varied slightly from activity to activity). Table 10 below shows the completion rate— defined here in percentage terms as the number of people completing the first question in an activity divided by the number completing the last question in that activity— by subject and activity type (science or math activities) and grouped by education level for registered site visitors.

Web Lesson Activity Completions

	Some HS or Less		HS or GED		Some College		Total	
	N Started	Percent Completed	N Started	Percent Completed	N Started	Percent Completed	N Started	Percent Completed
Math	**640**	**78.6**	**197**	**81.2**	**137**	**92.0**	**974**	**81.0**
Bacteria	106	50.9	40	47.5	15	53.3	161	50.3
Carbohydrates	85	81.2	27	88.9	23	100.0	135	85.9
Heat	39	84.6	8	100.0	16	100.0	63	90.5
Photosynthesis	5	60.0	8	75.0	9	100.0	22	81.8
Sodium	45	71.1	15	73.3	15	100.0	75	77.3
Water	360	86.7	99	92.9	59	93.2	518	88.6
Science	**640**	**76.3**	**206**	**80.1**	**124**	**83.9**	**970**	**78.0**
Bacteria	88	80.7	60	86.7	16	100.0	164	84.8
Carbohydrates	101	73.3	28	75.0	19	84.2	148	75.0
Heat	53	94.3	16	81.3	13	92.3	82	91.5
Photosynthesis	114	44.7	25	44.0	20	45.0	159	44.7
Sodium	140	84.3	52	88.5	35	94.3	227	86.8
Water	144	86.1	25	88.0	21	85.7	190	86.3
Grand Total	**1280**	**77.4**	**403**	**80.6**	**261**	**88.1**	**1944**	**79.5**

Table 10

As the table shows, the overall completion rate for all site activities was 80 percent. Higher levels of education were associated with higher completion rates (77.4%, 80.6% and 88.1% respectively). Overall math and science completion rates were about the same (81.0% and 78.0% respectively) although those with higher levels of education tended to complete more of the math than the science activities.

An examination of completion rates for the individual science subjects reveals some anomalous findings. For example, the completion rate for the math bacteria lesson (50.3%) is considerably smaller, across all three groups than the completion rate for the science bacteria lesson (84.8%). Similarly, the difference between the completion rates for the science photosynthesis lesson (44.7%) is a good deal smaller than that for the photosynthesis math lesson (81.8%). In this instance however, the total number of 'lesson starteds' recorded by the system is very low. There is nothing in the data that was collected that offers an explanation of these differences. They may be related to the relative strength of the content in each subject, TV411's site SEO (search engine optimization) strategy, the interests and capabilities of visitors, or the special efforts that were made to administer the CKTs to students at the Mid-Manhattan Adult Learning Center. Overall, however, we do believe they indicate very clearly that the web lessons were successful in engaging the vast majority of registered visitors who viewed and interacted with them.

WEB ANALYTICS

We noted briefly at the beginning of this report some of the concerns we had about using web analytics (WA) data in our evaluation of the TV411WC site. While there is an abundance of such data available,

interpreting it for a site like TV411 is problematic. Web analytics data is collected via a "cookie," a small bit of computer code that a website transfers to the client computer accessing its pages. Cookies store and can transfer back to the website from which they originated information about the client computer such as its approximate location (which is usually embedded in its unique IP address), the type of browser used to access the site, the computer's language settings, and, most important for our purposes, a record of the pages viewed on the computer, including the date and time the page was viewed, the event that preceded and followed such viewing, and the length of time for the page view. The problem with cookies is that the data they collect is specific to the computer accessing the site *and not* the individual actually viewing the page. For web destinations where there is an expectation that only a single individual is accessing a site, the data collected is normally treated as individual level data. This expectation may not hold with the TV411 data, however, because many individuals are likely to be accessing the site from shared computers such as those found in schools, adult educations settings, and public libraries. There is no way around this problem except to offer some cautions about interpreting analytics data.

Table 11 below shows that completion rate for each of the web lessons on the TV411WC site. It is similar to the data presented in Table 10. Although the actual percentages figures differ (most likely because the data reported above includes only registered users who are more likely to be committed to the site's offerings), the overall trend is similar. Overall, the majority of visitors who start a web lesson take the time and effort to complete it. From this, it is possible to infer that they view the content as valuable and engaging.

Web Lesson Completions from Web Analytics Data

Subject	%
Bacteria	51%
Math	52%
Science	50%
Carbohydrates	54%
Math	64%
Science	45%
Heat	63%
Math	68%
Science	56%
Photosynthesis	54%
Math	45%
Science	63%
Salt	62%
Math	57%
Science	67%
Water	64%
Math	63%
Science	64%
Grand Total	58%

Table 11

ACQUISITION OF SCIENCE AND MATH CONTENT KNOWLEDGE

A core component of the TV411WC evaluation was an assessment of the knowledge visitors gained after they experienced the site's content—simply put, did they learn the material? Learning was assessed using six content knowledge tests (CKTs) designed to cover both the math and science content presented in each module. As noted in the methodology section of this report, we had planned to examine the degree to which dosage affected CKT scores using analysis of variance procedures. By "dosage," we mean the number of elements in each module visitors experienced (none, video only, video and one web lesson, etc.). Again, as we discussed earlier, the fact that visitors were not required to log in considerably reduced the number of CKTs available and confounded our ability to accurately track dosage. The findings from this part of the analysis therefore need to be interpreted cautiously.

Table 12 shows the number of CKTs that were collected in each subject area by education level for registered visitors. As the table shows, the addition of visitors in the "Some College" category adds little to the total number of CKTs in each subject area, so this group was eliminated from the analysis of CKT scores. Table 13 shows the number of CKTs available for analysis in each dosage category(CO = CKT

Number of CKTs Available by Subject and Educational Level

	Some HS or Less	HS or GED	Some college	Total
	N	N	Count	Count
Bacteria	59	22	4	85
Carbohydrates	52	10	8	70
Heat	23	3	3	29
Photosynthesis	32	4	6	42
Salt	40	17	9	66
Water	102	23	11	136
Total	308	79	41	428

Table 12

Number of CKTs Available in Each Dosage Category

	CO	V	L	LL	VL	VLL	Total
	N	N	N	N	N	N	N
Bacteria	52	18	7	0	4	0	81
Carbohydrates	21	7	21	0	13	0	62
Heat	12	7	5	0	2	0	26
Photosynthesis	20	9	5	0	2	0	36
Salt	45	7	5	0	0	0	57
Water	59	4	56	0	6	0	125
Total	209	52	99	0	27	0	387

Table 13

only/ no dosage, V = Video Only, L =Web lesson Only, combinations indicate multiple instances of the same treatment). As the table illustrates, there are very few CKTs in the video and lesson category (27 in total) and none in the two lesson or two lesson and one video category. Moreover, there are only two instances in which there are a sufficient number of CKTs in the different dosage categories to allow for a

within subject analysis. These problems are further exacerbated by the fact that there are 22 cases in which most of the CKT answers are missing. We present the data below with these cases removed. The revised Ns are provided in the table.

Each CKT consisted of between 10 and 13 items each. The scores presented in Table 14 show the number correct divided by the number of items in the CKT. While the number of observations for all but the

CKT Scores

	CO		V		L		VL	
	Count	Mean	Count	Mean	Count	Mean	Count	Mean
Bacteria	51	47.5	18	55.6	7	55.7	3	76.7
Carbohydrates	21	47.6	7	57.1	18	50.6	13	50.8
Heat	12	37.1	7	46.8	5	38.2	2	40.9
Photosynthesis	20	61.5	9	67.8	4	55.0	2	75.0
Salt	44	46.5	7	57.1	4	55.8	0	.
Water	56	51.9	3	57.6	47	48.9	5	60.0
Total	204	49.3	51	57.1	85	49.8	25	56.9

Table 14

water module is very small, comparisons of the aggregated scores are possible. The analysis of variance procedure yielded a statistically significant result for the overall model (alpha = .047), but post-hoc comparisons showed that the only statistically significant differences are between the CKT only (CO) condition and the video only (V) conditions (alpha =.017), and then only using the most liberal least-significant difference (LSD) post-hoc test. The Games-Howel and Hochberg GT2 procedures which may be more appropriate when sample sizes differ, failed to show significance (alpha = .084 and .097, respectively). Moreover, even if we accept the results from the LSD test, the effect size was small (.148), indicating that the video had very little impact on knowledge gain. In addition, two subject level comparisons between the scores on the bacteria CKT for the CO and V conditions and the water CKT for the CO and L conditions were conducted. Neither set of differences however were statistically significant.

In making sense of these findings, it is important to bear in mind that the original evaluation plan was designed to look at dosage. Although we had expected to see some improvements in science and math knowledge among those who viewed the videos or completed a single web lesson, it was our theoretical belief that the differences with the largest effect size would be observed at the highest dosage levels. For this reason, the CKTs were specifically designed to be challenging for visitors and included questions that could only be answered by visitors who completed the video and both web lessons. Under these circumstances, it is little wonder that the reported gains in scores were so modest, since visitors were given a test that included topics not covered in a single web lesson or video.

SUMMARY OF FINDINGS

Visitor Demographics

While we reported demographic data for registered users, they represent only a small subset of the total visitors to the TV411WC pages. Moreover, the data we do have is biased because of an over-representation of cases from the Mid-Manhattan Adult Learning Center students and others who were recruited to build CKT and survey responses.

Recommendation: We believe that it is possible to collect demographic data from visitors even without requiring registration. For example, a pop-up survey could be presented to randomly selected visitors with the data collected anonymously. There are several interpretive challenges with data collected in this manner, but it would provide a better sense of who is visiting the site than the current registration system does.

Visitor Engagement

It was clear from the group discussions and our observations that visitors to the site found it accessible and valuable. As we learned from our observations at the Mid-Manhattan Adult Learning Center, our interviews and observations at the Cornell Cooperative Extension program, and from the web analytics data, the site content was successful in engaging adult learners and holding their attention. This was true both for the videos and the web lessons (when they were used). Based on what visitors told us, the content was appropriately leveled for the target population, and even though some visitors found it challenging, most felt well supported as they progressed through it. That said, we observed more than a few users who were challenged by the computer skills required to navigate and interact with the site. We are not at all suggesting that the site was difficult to use, but rather pointing out that basic computer skills are required to interact with it.

Web lesson and video completion rates also provide solid evidence of visitor engagement. As we show in the table on page 16, the overall completion rate for all site activities was eighty percent. However, we did report lower completion rates in some subject areas.

Recommendation: TV411 staff should communicate to organizations using the site in their programs that basic computer skills are required. They should continue to closely monitor site usability with diverse populations in order to learn whether persistent stumbling blocks exist for visitors, and, when possible, take steps to remove them. Such an effort would also enable TV411 to better understand why completion rates across subject areas varied as much as they did.

Attitudes Towards Science and Math

Even before viewing the TV411WC content, respondents saw science and math as important to them personally and relevant to everyone in a technological society. At baseline, they also reported finding science interesting and something they wished to learn more about. Confidence in their ability to learn and understand science and math concepts, however, was mixed and varied with their level of education. That said, slim majorities did report confidence in their ability to learn both subjects. Unfortunately, it

was impossible to assess the impacts of the TV411WC on their attitudes due to the exceptionally low response rate on the post-exposure survey.

Recommendation: Although the number of completed pre-surveys was not large, we were surprised by the extremely low response to our incentivized requests for participation in the post-survey. Despite follow-up and a very low email bounce rate, only nine post-tests were completed. As we discuss in the conclusions to this report, we believe that the only way to assess attitudes would be as part of a panel study conducted under controlled experimental conditions.

TV411 in Informal Educational Settings

It was clear from the interviews that the informal educators we observed and interviewed were enthusiastic about the videos and would use them again. They reported that the recipes were appealing, well presented, and appropriate for their students. With the provision of the teachers' guides and the extra training they received, they were able to integrate the science and math content into their already existing nutrition lessons in a way that was comfortable and positive for their students. The students we observed appeared interested and engaged in the video and in the science discussion that followed. Overall, the TV411WC videos add value in informal educational programs that touch on science or math related issues.

Recommendation: A key requirement for success in informal settings is educator support, both in the form of lesson plans and teacher training. It was only after these had been strengthened in September 2012 that we observed the reported successes. Moreover, we believe that the recommended lesson plans and training need, at least to some degree, to be customized for the settings in which the videos are used. Finally, we would like to see further study of how the TV411WC materials are used and how successful they are in other subject areas, with different populations, and in other locales.

Science and Math Knowledge and Understanding

Encouragingly, the qualitative data we gathered suggest that TV411 was successful in transmitting science and math knowledge to visitors. However, this evidence, gathered in our observations and interviews, was limited, and therefore we cannot say with certainty that the site was successful in this capacity. As we discuss in the conclusion, the assessment of knowledge acquisition and retention was to have been based on quantitative data collected from visitors who experienced the TV411WC content at different dosages. Without such data, we can only base our assessment on the limited qualitative findings, and therefore cannot conclusively determine TV411WC's outcomes in this area.

Recommendations: We recommend that future studies of this kind adopt a panel design in which experimental subjects matching the background characteristics of the site's target population go through the materials under controlled conditions. Such a design would circumvent the challenges faced in this study and, we believe, enable a better validation of the site's impacts on the development of science and math knowledge.

CONCLUSIONS

It was clear from the data we gathered for this study that visitors to the TV411WC site found the content accessible, engaging, and valuable. However, because of the myriad evaluation challenges presented in this report, it is difficult to determine, based on the data collected, whether the TV411WC project was able to achieve many of the goals described in the first page of this document and reproduced below:

1. Improve adults' awareness of how key math and science concepts that they often hear about in the news connect to their lives.
2. Help adults overcome negative attitudes and behaviors about tackling science and math topics viewed as too challenging or too hard to understand.
3. Increase adults' knowledge, vocabulary, and skills related to science and math
4. Increase the comfort level, understanding and capacity of adult educators and informal workshop facilitators to teach basic math and science concepts.

Goal 1 depended upon comparing responses in the attitudinal survey over time but the post-test yielded too few responses to make such comparisons possible. Strictly speaking, goal 2 also required data from a post-test though there was evidence in our limited qualitative discussions and observations that learners interacting with the site were comfortable with the material and did not appear to view it as particularly hard to understand. As the pre-test survey data show however, many respondents do not believe that science and math topics are in fact too challenging. Goal 3 of course was dependent on the CKT study. The data we have in this area are limited and the findings, where we do have data are inconclusive. The situation with goal 4 is different. Here, we were able to follow the original evaluation design and can report clear success. The science videos produced under the grant along with the associated teachers' guides represented a positive, valuable addition to the informal education settings in which they were deployed.