Impacting the Future by Leveraging the Past

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Abstract

The paper presents an overview of a pilot project that utilizes the rich historical archives of General Electric's (GE) science & technology to augment the production of new educational materials; including a wonderful series of 23 scientific comic books that GE produced between 1946 and 1959. The paper discusses how images of physical artifacts and historical documents have been integrated with the comics and other archival pieces to produce interactive web-based learning modules that are geared toward K-14 grade levels. The paper describes the piloting of prototype web-based educational materials for students in grade 4 (electricity) and lower level undergraduate courses (engineering) – in an attempt to inspire students to pursue a science or engineering degree program. The initial pilot testing and assessment efforts of the project are presented in conjunction with our intent to help K-12 students and teachers meet the rigorous NYS science standards.

Motivation

U.S. students are typically exposed to the use of computers in the K-12 classroom or media centers, yet rarely link their use of technology in school with how they use computers at home. They now have greater opportunities to garner knowledge by accessing and using information than ever before. Even with such technology, we need to bring more dynamic materials and engaging education into the home to reinforce and broaden our children's understanding of the concepts that are introduced at school.

Contemporary K-12 students immerse themselves in computer games and instant messaging, while using a browser-based search engine that instantly accesses new media and subject matter. Their enhanced ability to perform a number of tasks while also carrying on multiple communications using a variety of media - can lead to boredom and impatience if they are not appropriately stimulated. This effect confronts academia and influences educators to teach in more engaging, dynamic, and interactive ways. Bored grammar school students have difficulty retaining focus in math and science classrooms, resulting in fewer high school graduates that choose to pursue technical careers. Unfortunately, today's products call for advanced skills in science, math, engineering and technology, yet the number of graduating engineers in the U.S. is declining in comparison to other countries such as China and India. This issue is clearly of concern to the competitive outlook for U.S. industry and, consequently, U.S. citizens.

We need to use technology to help us address the declining number of U.S. students entering STEM oriented fields by utilizing dynamic and compelling media to re-engage and inspire today's adolescents. General Electric (GE) had recognized the potential for capturing the interest of K-12 students in the 1940's and 1950's through the creation and distribution of technology oriented comic books (as depicted in figure 1 below).

Figure 1 - Sample Pages from GE Comic Book #1

Comic books have historically been banned in K-12 environments, viewed by the administration as diversions that students would be reading during a teacher's instruction. Now comic books are viewed as an old-fashioned way to encourage reading, drawing and writing in an age of internet surfing and television watching. Art teachers have incorporated lessons that teach students how to brainstorm character ideas and write lively, concise thought boxes for the plot lines. Students come up with characters, a problem, a resolution and a moral, exactly as their teacher had requested.

The impact of such products helped General Electric fill the projected recruitment needs for the future technology boom that was predicted in the early 1950's era. The comics had a broad appeal and exposed many future GE technologists to the underlying concepts and products that were in the process of being researched and developed. We hope to now leverage this strategy, utilizing the rich historical archives of GE along with the dissemination and distribution opportunities of the Internet to develop engagingly interactive STEM oriented learning materials that help address the difficulties associated with stimulating interest in technical careers today.

Project Overview

The pilot project uses the Schenectady Museum and Planetarium's (the museum) historical archives of General Electric (GE). Elements such as lab documents, photographs, marketing/promotional documents, physical artifacts (light bulb prototypes, AC motors, x-ray tubes, etc.), and a wonderful series of 23 scientific comic books that GE produced between 1946 and 1959 are in the process of being incorporated into web-based materials (as depicted below in figure 2).

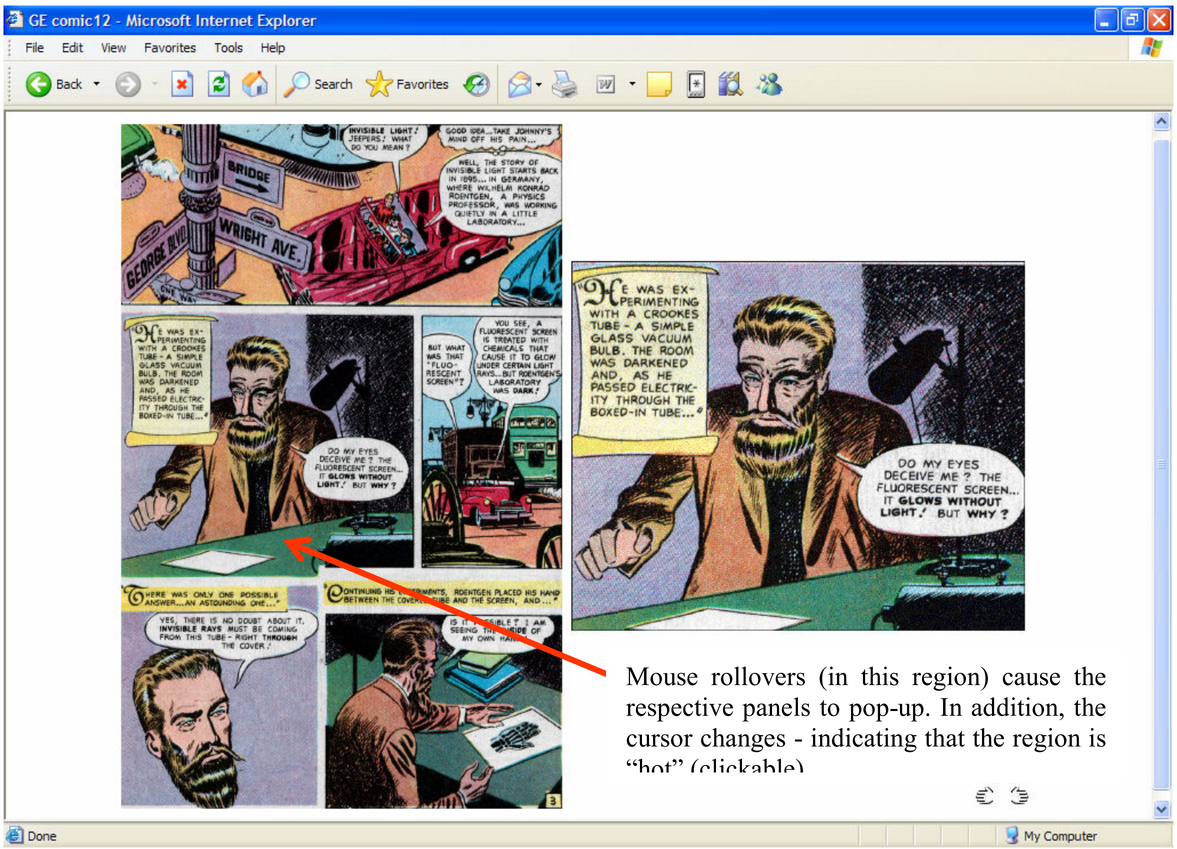

Figure 2 - Sample Screen from Pilot Interactive Comic Module

These comic books were designed to educate junior and senior high school students about electrical principles and their application to invention and product development. GE originally developed the comic books to generate interest in technology and offset a shortage of science and engineering graduates; although only a select few of these national comic treasures remain today. We are attempting to bring these back to life by converting and integrating the comics with the vast resources of the web - via links, dynamic electronic media, and supporting interactive simulation environments. The unique collection is being used to produce interactive 21st century learning modules/objects appropriate for pilot testing. The effort combines the award-winning multimedia development expertise of Rensselaer's Academy of Electronic Media, with input from K-12 teachers and the museum's education specialists to storyboard, develop and test the interactive learning materials.

The museum has provided source materials selected from its International Technology Archives. These items have been used in developing educational content that support and add to the comic books. Images, illustrations, photos, audio and video will also be used to help teach scientific principles. Primary source materials, including articles, correspondence, laboratory notebooks and patents, are being used to research, develop, and produce multimedia materials presenting electricity and its application to the technological development of products. The Museum's moving image collection consists of more than 1800 films and video relating to the development of the electrical industry that often feature inventors discussing their discoveries. For example, Exploring with X-rays features Dr. William Coolidge (the inventor of the X-ray tube in 1913), discussing the history of X-ray research and development along with the scientific principles behind X-rays. Selected artifacts from the Museum's 20,000 object technology collection have been photographed for use in conjunction with the comic books. Photographs from the Museum's 1.5 million-image GE Photograph Collection have also been leveraged to create additional visual resources depicting inventors, research, and subsequent product development.

A project team of K-12 teachers, assessment specialists and researchers from the Niskayuna School District, Rensselaer Polytechnic Institute, University at Albany, and the museum are involved in producing the curriculum, evaluation criteria, and specific outcomes along with partners from Rose-Hulman Institute of Technology and Howard University. The prototype materials are being piloted and evaluated in the schools (at the time of this writing) with a full-scale evaluation/assessment planned for fall 2005. Subsequently, the pilot materials will be officially launched and made openly accessible via the Internet.

A key objective of the project is to develop a successfully piloted educational prototype for students in fourth grade (electricity) and lower level undergraduate courses (engineering) - that inspires them to pursue and complete a science or engineering degree program. Another objective is to provide innovative educational materials to help students in grades, 4, 8, and 12 meet the rigorous New York State (NYS) science standards – in compliance with the No Child Left Behind (NCLB) efforts.

Sample Pilot Module: "Exploring Connectivity"

Electricity is first introduced in the New York State fourth grade science curriculum. The unit covers the concept of a battery (power sources), electrical energy, wire connections, voltage, current, and resistance. Two student activities are associated with the Niskayuna School District's offering of this unit, which are intended to help demonstrate the concepts of resistance and electrical connectivity. In the first activity, a class is divided into groups of four or five students that work together to create electrical connections on a piece of cardboard using aluminum foil. For example, two of the students first work together (out of the view of the remaining students) to lay out eight (non-overlapping) rectangular foil regions on a cardboard base and then use additional foil pieces to connect a subset(s) of the eight regions together (as depicted in figure 3). Once complete, the board is covered with another piece of cardboard that has eight matching rectangular cut-outs that expose the tin foiled areas below. One of the remaining students then uses a "probe" (consisting of wire, a light bulb and battery) to discover the underlying circuit. Given the amount of time allocated for the effort, not all the students in a class are able to be actively involved in either the circuit creation or hidden circuit discovery efforts. Unfortunately, only a relatively small portion of the class are actively engaged while the remaining students are left to simply observe the activity – potentially drifting off due to a lack of engagement in the hands-on efforts.

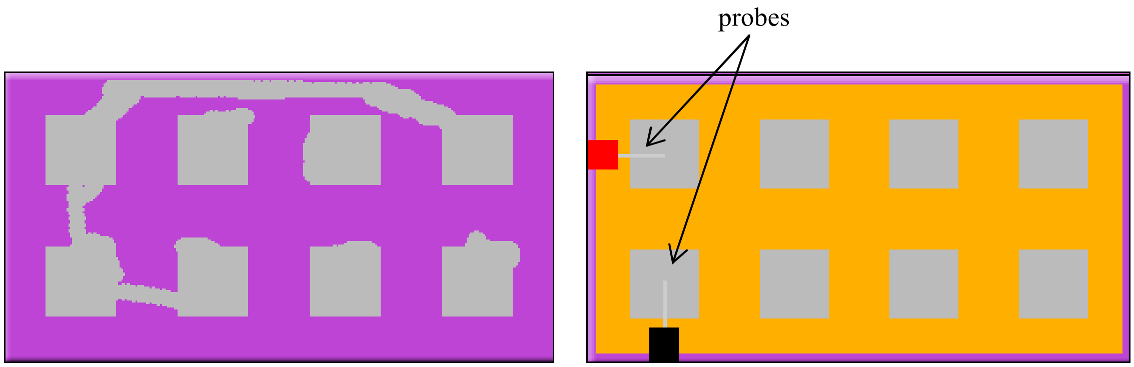

Figure 3 - Uncovered and Covered Versions of the Electrical Connectivity Activity

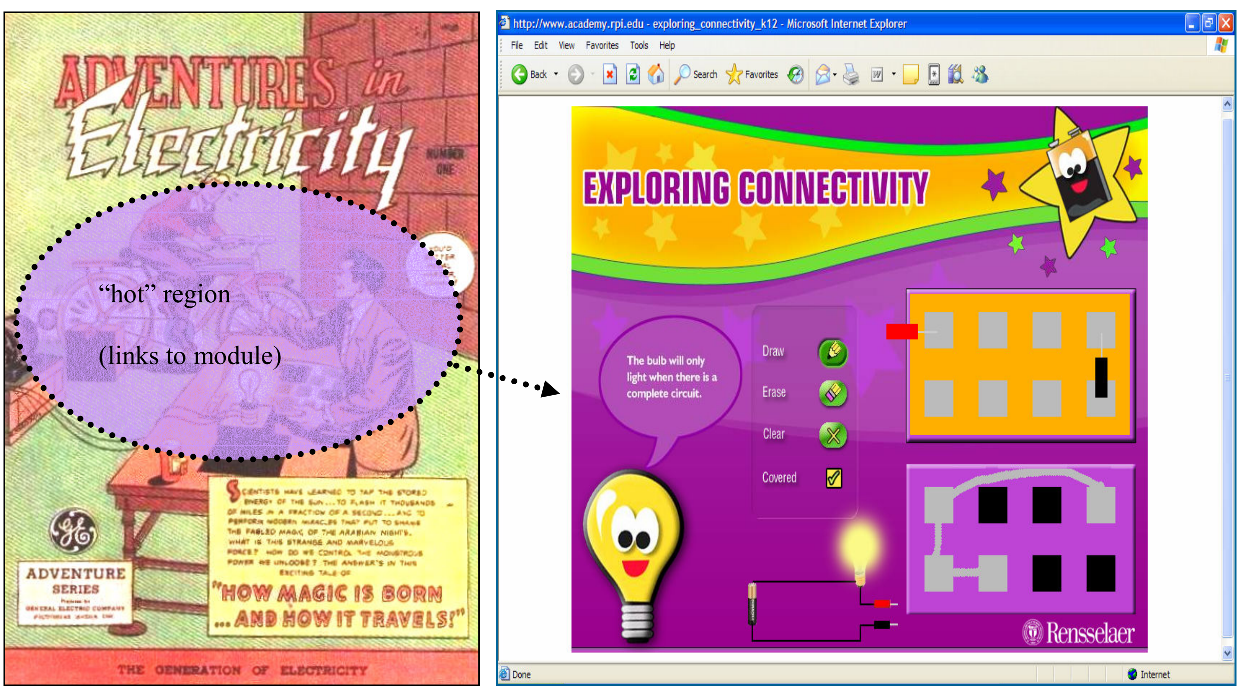

Figure 4 - Sample Comic Screen and Linked "Exploring Connectivity" Module
(http://www.academy.rpi.edu/projects/ccli/modules/k12/exploring_connectivity_k12.htm)

In order to overcome the lack of opportunity to fully engage all of the students in a class, a virtual module was developed to replicate the key elements of the hands-on classroom activity. Figure 4 illustrates the comic book and linked module that allows users to perform the aforementioned activity in a web-based virtual environment. Once again, a user creates the hidden circuit using a mouse-driven paint brush and then covers up the design. The partnering student is then asked to discover the underlying connections using a virtual probe – in which a light bulb lights up whenever a connection is made between the red and black probes.

The pilot study first completed the activity in the standard physical format, but then engaged the "remaining" students by having them complete the same process using the virtual module. As a follow-up experience, students were asked to go home and explain what they did in class to their respective family members. Afterwards they were to perform the same activity with family members and then switch the roles in an attempt to further scaffold their understanding of the underlying concepts. Finally, the family members were asked to complete a feedback form that documented what was explained to them and the understanding they garnered from the experience. Similar activities were also piloted in an introductory Electric Circuits class at Rensselaer using the module – albeit with a more "mature" looking graphical design (but with the same functionality).

Figure 5 - Sample Screens from the "Exploring Resistance Module"
(Linked to GE Comic Book #1)
(Top: K-12 skin, Bottom: lower undergraduate skin)
Illustrating the Difference Between Thin {higher resistance} & Thick {lower resistance} Wires

Project Evaluation

Project developments will be tested and evaluated in diverse situations (similarly to the process performed in many prior NSF projects): in 4^{th} grade and lower undergraduate courses – offered at Craig Elementary School, Howard University, and Rensselaer in January 2005. The diverse testing situations will yield key information on the relative success of the project, and will contribute to further refinement/development of the materials and museum exhibits. Students from under-represented student populations will be specifically targeted in the Schenectady, NY school district. Schenectady City Schools (an inter-city district), Niskayuna Schools (a suburban NY school district), Rensselaer, Howard University and Rose-Hulman (a varied group of engineering schools) offer a diverse platform of students to address and positively impact. In addition, the traveling museum exhibits and supporting physical display materials will be made available for use in other locations in order to expose a wider community to the project developments.

Evaluators from the Evaluation Consortium (located within the University at Albany) will assess the project and its implementation effect. The Evaluation Consortium serves as a training practicum site for graduate students in the field of program evaluation and is active in the design and implementation of innovative evaluation methodologies at the regional, national and international level. Specific areas of emphasis include K-12 and Higher Education curriculum and instructional evaluation; technology integration, and distance learning in traditional and workforce environments.

Pilot data will be collected from teachers, faculty, students and museum educators using the materials in the spring of 2005. The project will additionally be evaluated in several ways. First, student's success in subsequent course work at the participating institutions (K-12 and college) will be tracked. Second, the lower undergraduate courses will be evaluated by industry and ABET evaluators as a part of institutional programs.

Interim Conclusions and Future Plans

The pilot project is leveraging historical archives to provide a context for integrating science and technology within the school, the home and the community. The resulting web-based comic and linked materials/modules engages and inspires students in STEM education by coupling factual high-technology based comic books with internationally significant collections – in both creative and useful ways. We will continue to augment these materials and will widely disseminate the products via a combination of workshops, publications, teacher's guides, special museum programs, a traveling exhibit (that can be displayed in other prominent locations) and K-14 educational initiatives.

The pilot project has exhibited broader impact by providing students the ability to access the materials at their own pace (in a format they are accustomed to and enjoy), while additionally providing teachers with innovative STEM educational materials to utilize both in/out of the classroom. The additional module materials will focus on technical areas covered by science testing that is part of the No Child Left Behind act, while also aiding institutions that are trying to comply with state standards.

Comic books can be powerful education tools and reach across race, gender and ethnicity – ultimately recapturing the wonderful imaginations and overcoming the diminished attention spans associated with the current generation of students.

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