They were asked to serve, and math was their secret weapon.

INTRODUCTION

In September of 1941, sixteen-year-old twin sisters Doris and Shirley Blumberg were beginning their senior year at Girls High School in Philadelphia. Twelve hundred miles away, ambitious sixteen year old Betty Jean Jennings was beginning her first semester at Northwest Missouri State Teacher’s College. Although all three girls were college bound, they had few plans beyond graduation. But less than three months later, on December 7, 1941 the Japanese bombed Pearl Harbor, throwing the US into World War II and setting the three girls on a course that would change both their lives and history.

_The Computer Wore Heels_ (TCWH) is an interactive book app, adapted from the award-winning documentary _Top Secret Rosies: The Female Computers of WWII_ (www.topsecretrosies.com). This interactive app shares the story of three teenage girls who used their brainpower to help the US win WWII. As a student reads the story, s/he will be able to choose to investigate primary sources related to the action, such as archival films, audio clips, period documents and photographs. This book app will offer students, particularly young women, much needed role models in the area of science, math and computer engineering. Combining classic text-based storytelling with interactive media elements, _The Computer Wore Heels_ shares an important story of female computer pioneers who used their math skills to help win a war and usher in the modern computer age.
HOW TO USE THIS EDUCATIONAL GUIDE

This guide is designed to assist teachers in creating class activities organized around five lessons. The lessons could be conducted as a weeklong unit, but the lesson timeframe is flexible. The non-fiction story at the heart of the book app touches on many different study areas including lost women’s history, math’s role in war and the development of the electronic computer. Because of this, the app can be used across curriculum areas with great success.

Each lesson is organized around specific chapters of the book app and teachers are encouraged to create appropriate follow up activities, such as reflective writing, group discussion, research assignments, etc. The era covered in the app spans the end of the Great Depression through post WWII America.

Possible concepts to explore with students include:

- The importance of train travel in 1930s-40s America
- News and entertainment via radio and movies
- Limited access to electricity and phone technology
- Gender related high school/college graduation rates
- Statistics on career options for women (quota systems limited female enrollment in the hard sciences)

Advanced topics to investigate include:

- Gender roles in 1930s-40s America, expectations and realities
- Racial segregation and discrimination in 1930s-40s America
- Poverty and class inequity
- War propaganda, the Axis’ and the Allies
BACKGROUND INFORMATION

This bookapp may be used by many different teachers at different educational levels and in a variety of study areas. Because of this, the following links are offered to help teachers prepare activities based on the five lessons.

General Teaching and Research links:
http://www.archives.gov/education/lessons/depression-wwii.html
This site offers lesson plans on topics from the Great Depression - WWII.

http://www.nsa.gov/about/cryptologic_heritage/center_crypt_history/publications/how_math_helped_win.shtml
This url is the article “How Mathematicians Helped Win WWII” which shares background information pertinent to the bookapp subject.

http://www.history.com/this-day-in-history/
Teachers or students may use this link to look up historical highlights associated with any specific date in history.

https://archive.org/
This is a great general site to explore historical media in a variety of formats. Students could conduct research, read historical documents, watch archival films, and listen to archived radio broadcasts from the era covered in the bookapp.

This link is an archive of New York Times newspaper headlines from WWII.

http://www.eyewitnesstohistory.com/
This is a great general site for historical research.

Links appropriate to Math or Computer Science teachers:
http://www.edu-cyberpg.com
The Educational Cyberplayground site is a resource list for teachers.

One of the earliest analog math computers was the abacus. This link features a simple animation of an abacus in action.
LESSONS AND LINKS

The five lessons for *The Computer Wore Heels* bookapp are outlined below. Each lesson begins with students reading the assigned bookapp chapters and exploring the interactive elements included in each chapter. After the reading session, teachers will initiate activities appropriate to the lesson topic and their area of study and/or grade level. Where appropriate, chapter-specific research links are included. Following the lesson outlines are suggestions on age and topic appropriate educational activities.

Lesson One covers TCWH bookapp chapters 1-3

1- *On the Train to California*
Introduces characters Doris and Shirley, the Blumberg sisters.

2- *December 7, 1941- Uncle Sam Needs You*
Introduces Betty Jean Jennings and includes the Girl’s High recruitment episode.

Additional research links for Chapter 2:
Audio clips of President Franklin D. Roosevelt’s fireside chats

http://www.archives.gov/education/lessons/wwii-posters/
Link to research and view WWII government posters aimed at recruiting women to work for the war effort.

http://crfimmigrationed.org/index.php/lessons-for-teachers/144-hl5
Link for class lesson on immigration of Jewish Holocaust refugees.

3- *Wanted: Junior Computers*
Introduces the math work the girls were doing- includes original appointment letter and actual math equations sheet.

Additional research link for Chapter 3:
What is a differential equation?
Lesson Two covers TCWH bookapp chapters 4-5

4- Uncle Sam Needs Math
Introduces the Differential Analyzer. Introduces Joe Chapline (computing machine engineer) and Ed Sage (B17 lead bombardier).

Additional research links for Chapter 4:
http://www.ted.com/talks/malcolm_gladwell
This is a 15 minute TED talk on the story behind the Norden Bombsight and investigates the moral issues of war and technology.

http://www.uh.edu/engines/epi27.htm
This is a lecture on the Differential Analyzer- it includes an audio file of the lecture and links to pictures and other information on the machine.

5- The War Comes Home
Shares Shirley's story of the Battle of Anzio and Betty Jean’s work as a Rosie the Riveter at an aircraft factory.

Additional research links for Chapter 5:
http://www.history.com/topics/world-war-ii/battle-of-anzio
You’ll have to suffer through ads but this site has videos, audio and text on the Battle of Anzio.

http://www.dday.org/history/d-day-the-invasion/overview
This is a very thorough site on the D Day invasion.

http://www.u-s-history.com/pages/h1656.html
This is a great site on the history of Rosie the Riveter

Lesson Three covers TCWH bookapp chapters 6- 7

6- The Giant Brain
Introduces the top secret Army weapon Project PX, which will become ENIAC, the first multi-purpose electronic computer.

Additional research link for Chapter 6:
http://www.youtube.com/watch?v=k4oGI_dNaPc
A short promo video posted by the University of Pennsylvania on ENIAC.
7- *The Army Needs More Women*

The chapter opens with one of Ed’s battle stories from the Battle of the Bulge. The Army initiates a new recruitment effort, which brings Betty Jean to Philadelphia.

Additional research links for Chapter 7:

http://www.army.mil/botb/

This is a comprehensive site on the Battle of the Bulge, including newsreel footage from 1945.

Lesson Four covers TCWH chapters 8-10

8- *The Swing Shift*

The chapter opens with stories about the fun activities the girls engaged in during their off hours but ends by exploring racial segregation in Philadelphia during WWII.

Additional research links for Chapter 8:

http://www.youtube.com/watch?v=cbaNYWkQYYA

*Groovie Movie* (c. 1944 MGM) - A fun instructional film on the jitterbug dance. Soldiers representing the Army, Navy and Marines dance the finale.


This link covers the racially motivated Philadelphia Transit strike of 1944.

9- *Flags at Half Mast*

The chapter covers the death of President Franklin D. Roosevelt.

Additional research links for Chapter 9:

http://www.youtube.com/watch?v=ZrbyqUOObdU

Three minute video on the history of the automat.

http://www.eyewitnesstohistory.com/fdrdeath.htm

Eyewitness account of the death of FDR and the funeral that followed.


Archival radio announcement of FDR’s death.
10- The Beginning of the End
This chapter shares the announcement of the end of the war in Europe (VE Day) but the continuing war with Japan.

Additional research link for Chapter10:

Lesson Five covers chapters 11-13

11- The Computers and the COMPUTER
This chapter introduces the six women chosen as the programmers of ENIAC and covers the dropping of the Atomic Bomb, that ended WWII.

Additional research links for Chapter11:

Brief background history on the Manhattan Project.

12- The World Meets ENIAC
This chapter describes the first program installed on ENIAC.

Additional research link for Chapter12:
http://the-eniac.com/machine/
This site is a great, general site for all things ENIAC.

13- The Top Secret Rosies of WWII
The other TSRs, after the war- changes for women and minorities lead to modern civil and women's rights movements

Additional research links for Chapter13:
http://www.ellsbury.com/enigmabombe.htm
Very thorough site on breaking the German Enigma code.

http://www.nsa.gov/kids/home.shtml
This site links from the National Security Agency site and offers codebreaking activities for kids.

www.thecomputerworeheels.com
OTHER ACTIVITIES FOR THE CLASSROOM

Math, Science and Computer Science classes

Mathematics, Computer Science and other science classes often focus on the fundamentals of each discipline but the history of these areas of study offer opportunities to engage students on a different plane. For example, as they memorize theorems, complete equations and take tests, students often feel that math is an activity with no practical application to their lives. Yet mathematics is crucial to the development of new technologies and inventions, to the advancement of scientific investigations and, in the case of the The Computer Wore Heels, the successful execution of war.
An ideal use of the book app *The Computer Wore Heels* in math, science and computer classrooms would be to couple a lesson with a hands-on activity where students can put their math skills to use.

Suggested math, computer and science activities:

4-6 grades: Build and use an Abacus

The ancient Abacus is a hand calculating machine that is still in use today in parts of Africa and Asia. Each student will build his/her own Abacus and use it to complete mathematical problems. More elaborate projects could be created in conjunction with an arts program or community woodworking program but even tinker toys and wooden beads can be used to build a working Abacus. Below are links for sites on building and using an Abacus.

Make an Abacus for pennies using cardboard, glue, string and beads.  
http://www.galaxy.net/~k12/math/abacus.shtml

Here is a video clip from simplekidscrafts.com on making an Abacus using popsicle and BBQ skewer sticks.  
http://www.youtube.com/watch?v=Y1f3zH-7DY4&NR=1&feature=fvwp

How to Use an Abacus- detailed instructions on how to use an abacus to do addition, subtraction, multiplication and division. 
http://www.educalc.net/144267.page

PBS Teachers site- Mathline, contains PDFs for teachers and worksheets for students on using the Abacus.  

7-9 grades: Using Legos to teach Math, Computers and Engineering

Many of your students have probably grown up playing with Legos. They are fun and easy to use, yet can be the basis for robotic exercises that give students hands on math, computing and engineering experience. Plus, the students will have a cool object at the end!

This site is the clearing house for all things Lego and educational.  
http://www.legoengineering.com/

Here’s a site about Lego Mindstorms kits.  
http://www.nxtprograms.com/
9-12th grades and college: Solving Differential Equations
With older students, a project more directly tied to *The Computer Wore Heels* would be for students to devise a ballistics table for a military weapon. Variables affecting the trajectory of a projectile include atmosphere, wind, weight of the projectile, powder magazine, type of ground the weapon rests on, obstacles between the gun and target, and even the curve of the earth. Just like the women in *The Computer Wore Heels*, students must work in tandem, completing parts of the equation before combining all the results. Like in the bookapp, the moral implication of this intersection of math and war would be a good topic to raise and discuss.


Note: A PPT lecture on the history of human computing and WWII computing is available for download at [www.topsecretrosies.com](http://www.topsecretrosies.com) and includes graphics of actual math work completed by the female human computers working at the University of Pennsylvania during WWII

**History, Social Studies, Women’s Studies, Language Arts classes:**
Two important internet sites for any classroom activities based on *The Computer Wore Heels* and WWII are the National Archives site ([http://www.archives.gov/](http://www.archives.gov/)) and the Library of Congress site ([http://www.loc.gov/](http://www.loc.gov/)). At these two government-sponsored sites, students can research and view archival images, articles, newspapers, posters, film clips and more.

This LOC link outlines a variety of classroom activities of interest to teachers based on the American Folk Life collection. Suggested activities include lesson plans: [http://www.loc.gov/folklife/edresources/ed-classroom.html](http://www.loc.gov/folklife/edresources/ed-classroom.html)

Suggested activity:
**Art and Propaganda, the Poster project**

![Three recruitment posters, courtesy of the Library of Congress](image_url)

“We Can Do It” was an iconic poster of the WWII era, a pitch to women to do their bit for the war effort. What role does art and propaganda play in rallying citizens behind a cause? After discussion, students brainstorm a societal ‘need’ and create a poster on that topic.

Radio programming and propaganda during war-
Commercial Radio has been a staple of American society since the 1920s. In addition to offering entertainment in the form of music, skits and series, radio also played a crucial role in the area of broadcast journalism. Below are links to assist with a discussion of the role of radio in early 20th century life, with emphasis on WWII era broadcasts.

Archive.org houses a large collection of digitized WWII era radio broadcasts

Radio Propaganda, Another Weapon in War
http://radio.about.com/library/weekly/aa121902b.htm

Tokyo Rose and Japanese radio propaganda during WWII-
This is a great website with background information and related links to the story of Iva Toguri D’Aquino, aka Tokyo Rose.

This website offers background information on Tokyo Rose and mp3 files on CD of Tokyo Rose recordings are available for purchase.

Suggested Activity:
Create a Radio Broadcast-
History or Social Studies students can research a historical event, write commentary and record their own ‘radio’ show. For literature students, a book currently used in the classroom could serve as inspiration to create a radio broadcast inspired by the plot.

Sample WWII era radio broadcast- The Japanese surrender
August 14, 1945, amazing amateur recording of a radio broadcast announcing the Japanese surrender. Of particular interest, the announcement that once President Truman declares victory, “censorship will end in this country”.

www.thecomputerworeheels.com
Censorship and National Security-
A classic WWII era censorship case to investigate is the Chicago Tribune’s decision on June 7, 1942, to publish information that the US had broken a secret Japanese Code. Below are three internet sites where students can research this incident, sparking discussion of the role of censorship with regard to national security. A contemporary discussion subject would be the WikiLeaks scandal and the Edward Snowden case.

PBS site on the issue of National Security and the Role of the Press

WWII timeline January - July 1942

American Journalism Review- article “Judgment Calls”, October/November 2006
This AJR case includes the original article, making reference to the June 1942 Chicago Tribune article, and includes lesson plans, class assignments and related links.
http://ajrarchive.org/article.asp?id=4185

An Oral History Project-
Everyone has grown up listening to family stories. Whether handed down through generations or just occurring yesterday, stories help individuals grasp where they came from and may help them understand where they are going. Oral histories are a wonderful way of capturing everyday events that often hide behind the larger ‘history’ of our times.

Suggested Activity:
Create your own oral history-
The student will record a family story on audio or video and share it with the class. This can be done professionally with microphones, digital audio recorders and digital video recorders or it can be done inexpensively using computer recording applications or even cell phone recordings.

Sources:
This link offers Library of Congress lesson plans on using oral history as a way to investigate issues of culture, art, history, government and much more.

www.thecomputerworeheels.com
Veteran’s History Project, http://www.loc.gov/vets/about.html
“The Veterans History Project of the American Folklife Center collects, preserves, and makes accessible the personal accounts of American war veterans so that future generations may hear directly from veterans and better understand the realities of war.”

– Veterans History Project website

This site offers wonderful stories by veterans and would be a great first stop for students to listen and discuss some of the stories before attempting to record their own.

Storycorps, Every Voice Matters- http://storycorps.org/
Students can listen to stories recorded by regular citizens as part of NPR’s Storycorps project. After listening and discussing stories on the site, students may want to upload their own recorded family story.

Professional Mentoring
It is common knowledge that the US suffers from a shortage of young people interested in pursuing careers in the areas of Math, Computer Science, Engineering and other areas of the hard sciences. Particularly problematic is the shortage of girls and minorities working toward college degrees in these areas.

Offering students professional role models in the classroom is a wonderful way to encourage students, particularly girls and minority students, that math, computers and science can be part of their future.

Mentor/Role Models should be introduced as early as 4th grade and continue on through college classrooms. Teachers will need to outreach to their individual communities to identify individuals who could visit their classroom, discussing their own paths to their current career and demonstrating the diversity of jobs available that are based on math, computer and science skills.

Below is a list of professional organizations where teachers might find local chapters and classroom visitors but teachers are urged to engage with their communities, contacting local businesses, corporations and colleges for possible visitors/mentors. A business need not be a high tech firm to produce a possible visitor. The owner of the local bicycle repair shop probably uses math to tool and create replacement parts. The local museum director undoubtedly
has an IT staff organizing the collection, maintaining the museum website and creating digital files for upload. The best strategy is to secure a diverse group of visitors, demonstrating to students the wide variety of career opportunities using math, science and computers.

Professional organizations to contact:
AAUW, The American Association of University Women
“Breaking Through Barriers for Women and Girls”
http://www.aauw.org/

ACM, Association for Computing Machinery
www.acm.org

The Anita Borg Institute for Women and Technology
http://www.iwt.org/

AWC, Association of Women in Computing
http://www.awc-hq.org/

AWM, Association for Women in Mathematics
https://sites.google.com/site/awmmath/

AWS, Association of Women in Science
Assoc of women in science
http://www.awis.org/

BDPA, Black Data Processing Associates
http://www.bdpa.org/

CAARMS, Council for African and American Researchers in the Mathematical Sciences
http://www.math.buffalo.edu/mad/CAARMS/CAARMS.html

CRA-W, Computing Research Assoc- Women
http://www.cra-w.org/

IEEE, Professional Association for the Advancement of Technology
http://www.ieee.org/

NAM, National Association of Mathematicians
http://www.math.buffalo.edu/mad/NAM/

www.thecomputerworeheels.com
NSBP, National Society for Black Physicists
http://www.nsbp.org/

TERC (Technical Education Research Centers) is a research and development organization whose aim is to "improve mathematics, science and technology teaching and learning."
http://www.terc.edu/

WITI, Women in Technology International
http://www.witi.com/

ADDITIONAL ARTICLES

Below are links to articles that teachers may find informative.

Hands-on projects for students: These ideas are specific to particular communities but they would not be hard to duplicate in your own local city or town.
“Kindergarten Shop Class”, This article includes profiles on shop classes for children in NYC, Boston and San Francisco where math is an essential building skill. Is this something you could start in your own school district?
http://www.nytimes.com/2011/03/31/garden/31kids.html?_r=1

“The Hands that Steer are Building the Bikes”, This article shares information on the do-it-yourself bike movement, where people work together to custom make bicycles. Math is crucial to this endeavor and any community would have a bike shop where teachers and students could explore this practical application of math.
http://cityroom.blogs.nytimes.com/2011/03/05/the-hands-that-steer-are-building-the-bikes/

“Science and Secrets in New York City Playgrounds”, This article discusses unique science-themed playgrounds in the NYC area but every city or town has a parks department where science could be incorporated in to play. Perhaps your students would like to help design such a playground in their own community?
Informational articles:

“Why so Few?”- This 2010 study investigates why there are so few female scientists and engineers. Downloadable as a pdf from this AAUW website link. http://www.aauw.org/learn/research/whysofew.cfm