Using YA Fiction to Build Interest in STEM with Teen Girls

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Using YA Fiction to Build Interest in STEM with Teen Girls

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Why a difference?

• Girls and boys take sciences in elementary through high school education in equal numbers.

• High school girls and boys report that they intend to pursue STEM in college

• Female college students earn only 20% of STEM degrees.

Leaky Pipeline to STEM

1. Biological differences.
2. Lack of academic preparation in science for girls.
3. Poor attitude toward science of girls.
4. Absence of role models.
5. Science curricula irrelevant to many girls.
6. Pedagogy of science classes favors male students.
7. A ‘chilly climate’ exists for girls/women in science classes.
8. Cultural pressure on girls/women towards traditional gender roles.
9. An inherent masculine worldview in scientific epistemology.

Why it matters

- **Workforce projections**
  - 9/10 fastest growing fields in STEM
  - Biggest increases in Engineering and Computer Science (currently only 25% female)

- **Innovation including female concerns**
  - Early voice recognition programs not calibrated for female voices
  - Air bags were originally designed for males

- **Wage gap**
  - Women in STEM careers earn more than women in non-STEM careers
Reasons

• Biology
  – No difference in brain size
  – Famous male scientists had small brains
  - Spatial abilities show a 2 to 1 ratio NOT the 20 to 1 ratio seen in classes

• Preparation
  – Girls with strong STEM prep in high school still drop out in significant numbers from STEM majors in college

• Attitude
  – Slight difference in attitude towards science between boys and girls in HS
  – Same interest but **girls less likely to see themselves as scientists** (Baker & Leary, 1995)
Reasons (continued)

• Role models
  – Critical mass: numbers of women in STEM too low to maintain a visible population
  – **Image of successful female scientists** as less likely to have children (Sonnert, 1995)
  – Path to success was so unique to each female scientist makes it hard for younger females to replicate

• Curricula (Tai & Sadler, 2001)
  – Female students more successful with algebra-based physics
  – Male students more successful with calculus-based physics

• Pedagogy
  – Teachers marked assignments perceived to have been done by a male student higher than if they perceived the assignment was done by a female student
  – Gave less feedback to female students (Eccles & Blumenfeld, 1985)
Reasons (continued)

• Chilly Climate
  – Teachers predicted higher performance of male students over female students and had **lower expectations for female students**
  – Teachers rewarded boys who didn’t follow directions because they did more original work and **downgraded girls who followed directions** but assignments lacked “sparkle”

• Cultural pressure
  – Females report **conflict in dual roles** for being in the sciences and the primary care giver for their children

• Masculine worldview in science
  – Females historically excluded from clinical trials and **not seen** in research studies
It’s an image thing…

• Media featuring animated video of a female engineer (Plant et al., 2009)

• Growth mindset
  – When girls believe they can become smarter with practice, they are more likely to succeed in STEM

• Awareness of how STEM contributes to society
  – Females more likely to need to see a purpose for their work (Jozefowicz et al., 1993; Konrad et al., 2000; Margolis et al., 2002; Lubinski & Benbow, 2006; Eccles, 2006)
“A complex problem like this requires a multi-faceted solution”

p. 384
One possible facet....

Help young women see themselves in STEM using literature meant for them.
Hunger Games Hysteria

The surging trend of archery in pop culture has spiked interest and participation in bow sports nationwide.

**Figure 1:** Headline from Marullo, L. (2012). The Hunger to Shoot Better. *Texas Fish & Game*, 29(4), 21.

**Figure 2:** Headline from Idema, J. (2012). Movie points teens toward archery. *Grand Rapids Business Journal*, 30(39), 9.

**Figure 3:** Taylor, D. (2015). Hunger Games hysteria. *Parks & Recreation*, 50(3), 16.

Screening of film ‘Hidden Figures’ ignites interest in STEM among students


Hidden Figures: Inspiring STEM heroes for girls

Posted Jan 13, 2017 by Tracey Welson-Rossman

Research


Review of books

With STEM-interested protagonists
Physics


Use time travel and quantum mechanics to understand her grief and broken heart.

Figure 7: Book cover retrieved from publisher website

Figure 8: Image of Pi copied from text, *The Square Root of Summer* by H. R. Hapgood.

Figure 9: Image of paradoxical loop from text, *The Square Root of Summer* by H. R. Hapgood.

Figure 10: Image of Schwarzschild Metric from text, *The Square Root of Summer* by H. R. Hapgood.
Interactive Display

Figure 11: Display image retrieved from Pinterest.

What day/year would you relive?

High or Lo Tech

- Twitter exchange
- Facebook
- Physical bulletin board
- Padlet or Linolt
Physics


2011 winner of the William C. Morris Award

I didn’t tell Mr. Banacek that I’d been using the problem of the Freak Observer like a bunch of jingling keys to distract my brain. I didn’t tell him the Freak Observer is my space suit when I’m floating in the cold and the dark. I didn’t tell him that I cry for the other Freak Observers. I didn’t include that stuff, because that’s emotion—and emotion doesn’t belong in physics.

Figure 12: Book cover retrieved from publisher website
Citizen scientist event

Freak Observer
A self-aware being created by a chance that tries to make sense out of chaos

Galaxy Zoo from Zooniverse

- [https://www.galaxyzoo.org/](https://www.galaxyzoo.org/)
- Huge data set made up of a million images of galaxies that need classifying

Figure 13: Snippet of screen shot from Galaxyzoo.com

Computer Science


Figure 16 & 17: Book covers retrieved from Amazon.com.
Build a domino computer

Figure 18: Image of scene from Youtube video by standmaths retrieved from https://www.youtube.com/watch?v=OpLU__bhu2w&feature=share

Figure 19: Image of snippet from Think Maths website. Retrieved from http://www.thinkmaths.co.uk/downloads/domino-computer-worksheets

The OR gate is fairly easy to make from dominoes - we need two input chains, either of which will set off the output chain of dominoes. A domino OR gate looks like this:
Environmental Sciences


Figures 20 & 21: Book covers retrieved from author’s website.
Environmental Sciences


Figure 22: Image retrieved from author’s website.

Figure 23: Book cover retrieved from Amazon.com

Winner of the United Kingdom’s Costa Book of the Year Award in Children’s Literature.
More citizen science opportunities

- Frogwatch USA - https://www.aza.org/frogwatch
- Project Budburst - http://budburst.org/
- Great Sunflower Project - https://www.greatsunflower.org
Mathematics


We’re off the map…. We’re not where the world expects us to be…

Figures 24 & 25: Book covers retrieved from Amazon.com

I didn't miss a beat between each "C" I'd marked off on the math test because, quite honestly, it's absurd. The school administrators think I'm some kind of genius sheep. That my only purpose is to elevate the test scores of a public school on the brink of losing funding from the federal government. The rest of the class, deep in calculus hell, didn't want to hear about me, what a great student I was and how I'd save their advanced math program. All they wanted were tickets to Endless Horizon concerts and to get bent on Mojo Sticks.

(Deeb, 2016, p. 4)
Meet the mathekniticians - and their amazing woolly maths creations | Science | The Guardian

Meet the mathekniticians - and their amazing woolly maths creations

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Meet the mathekniticians - and their amazing woolly maths creations

Knitted Hexaflexagon Cushions, by "Mathekniticians" Pat Ashforth & Steve Plummer

Meet the mathekniticians - and their amazing woolly maths creations

Meet the mathekniticians - and their amazing woolly maths creations

Meet the mathekniticians - and their amazing woolly maths creations

Curve of Pursuit: Ashforth and Plummer's most popular pattern. The edges of the squares represent four points that are each moving towards each other. Each point is closing in on the next point clockwise to it.

Meet the mathekniticians -

Woolly Thoughts
http://www.woollythoughts.com

Figure 27: Screen shot of Pinterest search result for knitting and math


Figures 28 & 29: Book covers retrieved from Titlewave.com
Forensic Science Activities

Blood Spatter Drop

- Drop fake blood from different heights and angles
  - How height impacts the size of the spatter
  - How angle impacts the shape of the spatter

Fingerprinting on different surfaces

- Dusting
- Fuming


How, when my mother was alive, I had begged her to take me along on her expeditions, and how I still spent many evenings poring over her maps of strange and distant lands, tracing the faded lines of ink with my fingers.

Fawcett, 2017, p. 12
The Humanitarian OpenStreetMap

Virtually volunteer to help map areas affected by disaster

Figure 31 : Image from training walk through at Openstreetmap.org
Table of Contents

2.0 Delayed Reaction
   2.1 Acid
   2.2 Transition Element
      2.2.1 Base
   2.3 Caustic
   2.4 Crucible
   2.5 Reactants
   2.6 Boron

“Toby and I are the proton and neutron of our atomic family unit. Dad is the loosely bonded electron, negatively charged, zooming around us in his own little shell”

Chemical reactions

- Borax snowflakes
- Sun printing t-shirts or scarves
- Elephant toothpaste
- Pill dissolving
- Test pH using red cabbage
“Go to each corner of the bins, measure three inches, and make a mark.” I demonstrate. “At the opposite side of each corner, like so, measure four inches and make another one.” I draw another line. “If the distance between the two points is five, they’re square. Go check.”


Figure 33: Book cover retrieved from Amazon.com
Engineering

• Junk Drawer Engineering

• TeachEngineering.org
  – Able Sports – Design a new sport around a disability
  – Elephant Rail Car
  – Skateboard crashes (momentum)
  – Spinner competitions
  – Tightrope trials
It doesn’t have to be a STEM-themed book

Mysteries & the Scientific Method

- Observation
- Question
- Review information
- Hypothesis
- Testing
- Conclusion
- Communicate
Bringing Makerspaces to Literature, or Bringing Literature to Makerspaces

• Novel Engineering: http://www.novelengineering.org
  – Tufts University
  – Apply engineering approach to literature

• Tension-filled text
  – Brainstorm the problems being faced
  – Design a solution
  – Develop a prototype of the solution
  – Test it
Novel Engineering Example

• *Burn Baby Burn*

• Problem: Nora worried that her abusive brother will steal her money

• Design Solution: Create an alarm system; Build a better door lock; Camouflage a hiding place

• Prototype: Built it / Test it

Observations

- Science as a tool for understanding their world.
- Science is their ticket out of hometown.
- Lack of diversity
Questions? Comments?
Slides available at http://tinyurl.com/ybhcqncr

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