The Public Impact of Citizen Science Outreach & Education

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Citizen Science:

where the line between “public” and “researcher” blurs

Background:

How we have integrated science into society

(a view from HST)

Science Result

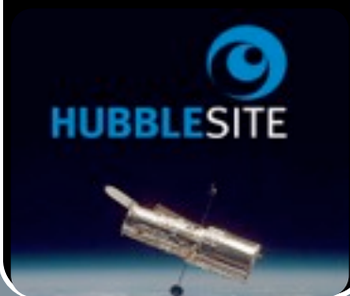
Scientist

Scientists work with communicators, educators, graphic artists, web developers and technical writers

Audience Needs

News

Outreach



Informal Education

Formal Education

Amazing Space

EXAMPLE:

AMAZING SPACE

For Everyone | For Educators and Developers

Homepage
A Hubble gallery
Servicing Mission 4
Online explorations
The Star Witness news
Capture the cosmos
Astronomy materials, by topic
Tonight's Sky
Homework help

What do you know?
Discussion questions
Wordwatch:

The Star Witness news

THE STAR WITNESS

TELE-SCOOPS FROM THE HUBBLE SPACE TELESCOPE

Feature AUG. 2013

A Horse of a Different Color

The expression "a horse of a different color" indicates something unusual or remarkable — something you don't see every day. To celebrate the 23rd anniversary of the Hubble Space Telescope, NASA released a new view of the Horsehead Nebula that provides an intriguing astronomical variation on that phrase.

ENLARGE

The Horsehead Nebula:
A dark nebula in visible light

Extras

PDF: *A Horse of a Different Color PDF*

Photo: *Horsehead Nebula in visible light*

Photo: *Constellation Orion the Hunter*

Photo: *Hubble's infrared view*

Photo: *Close-up of star-birth in*

SEARCH GO

The Star Witness brings you "tele-scoops" from the Hubble Space Telescope

NASA

News archive

- A Horse of a Different Color
- Pluto's Growing Family
- Hubble's Panoramic View of a Turbulent Star-Forming Region

Dark horse

SEE MORE

Orion the Hunter:
Find the Horsehead in Orion's belt

The Horsehead Nebula, also known as Barnard 33, was first recorded in 1888 by Williamina Fleming at the Harvard College Observatory. The nebula is located about 1,500 light-years away in the constellation Orion and can be found just below the star Alnitak on the left side of Orion's belt.

The visible-light view (at top of story) shows a black silhouette that resembles a horse's head. The shape looks a lot like the horse figure often used for a knight in the game of chess. Astronomers call the structure a "dark nebula," and it is made up of dense gas and dust.

Dark nebulae are cold and do not give off any visible light. Instead, they are generally noticeable because they block the light from background stars. Notice how many more stars can be seen above the Horsehead than below it in the accompanying picture. This observation shows that the Horsehead Nebula is part of a much larger dark cloud.

In contrast to the darkness of the Horsehead Nebula, the gas above it shines a bright pink. This pink glow occurs along the edge of the dark cloud and is caused by the giant bright star, Sigma Orionis, at the top of the image.

Looking deeper

ENLARGE

Hubble's view:
The Horsehead in infrared light

To see deeper into a dark nebula, astronomers use infrared light, which can pierce the dense nebula.

Hubble's infrared image transforms the dark nebula into a softly glowing landscape. It reveals much more structure and detail inside the cloud. As in the visible-light image, the region above the nebula, exposed to the light of Sigma Orionis, glows brightly. Hubble, however, has captured the fainter infrared glow emitted by the cooler gas within the nebula.

Notice also that the dense cloud of gas and dust has become more transparent. Many more background stars, and even some distant galaxies, can be seen through the thinner parts of the nebula.

Star birth

ENLARGE

Close-up:
A newborn star in the Horsehead

Many parts of the Horsehead Nebula are still opaque at infrared wavelengths. This fact shows that the gas is very dense and cold. Within such cold and dense clouds are regions where stars are born.

At the top of the nebula, as seen in infrared light, a bright star is surrounded by glowing gas. Gravity caused

Horsehead Nebula / Star Formation integrated into U.S. Middle School reading materials

25 Sept. 2013

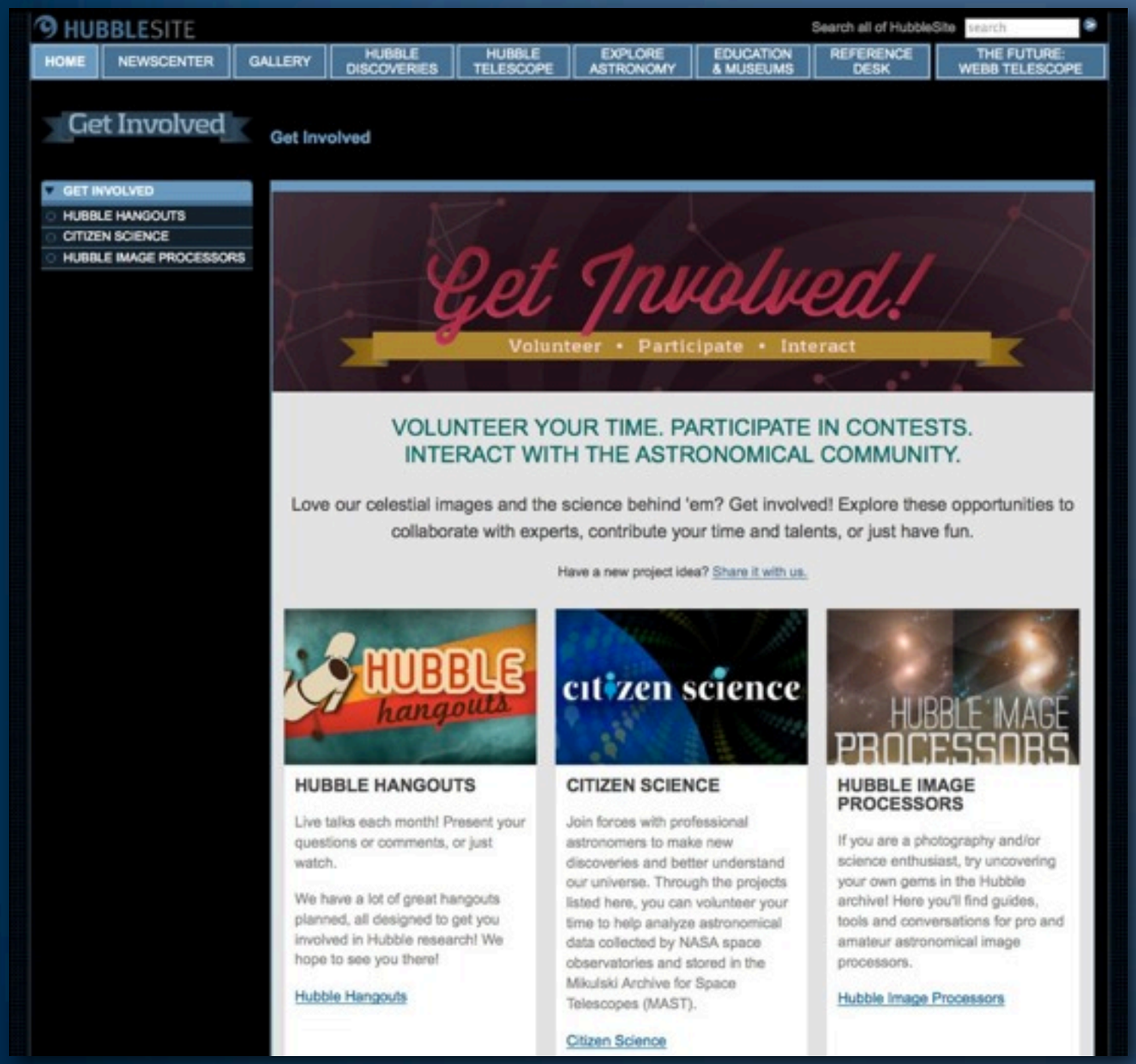
SPACE TELESCOPE SCIENCE INSTITUTE

Outreach

a system to provide services beyond conventional limits

OUTREACH

Online information, email alerts, social media (facebook, twitter, hangouts) interactions, Citizen Science



Watch, question, comment, interact, create your own images

Live talks each month
How science works.

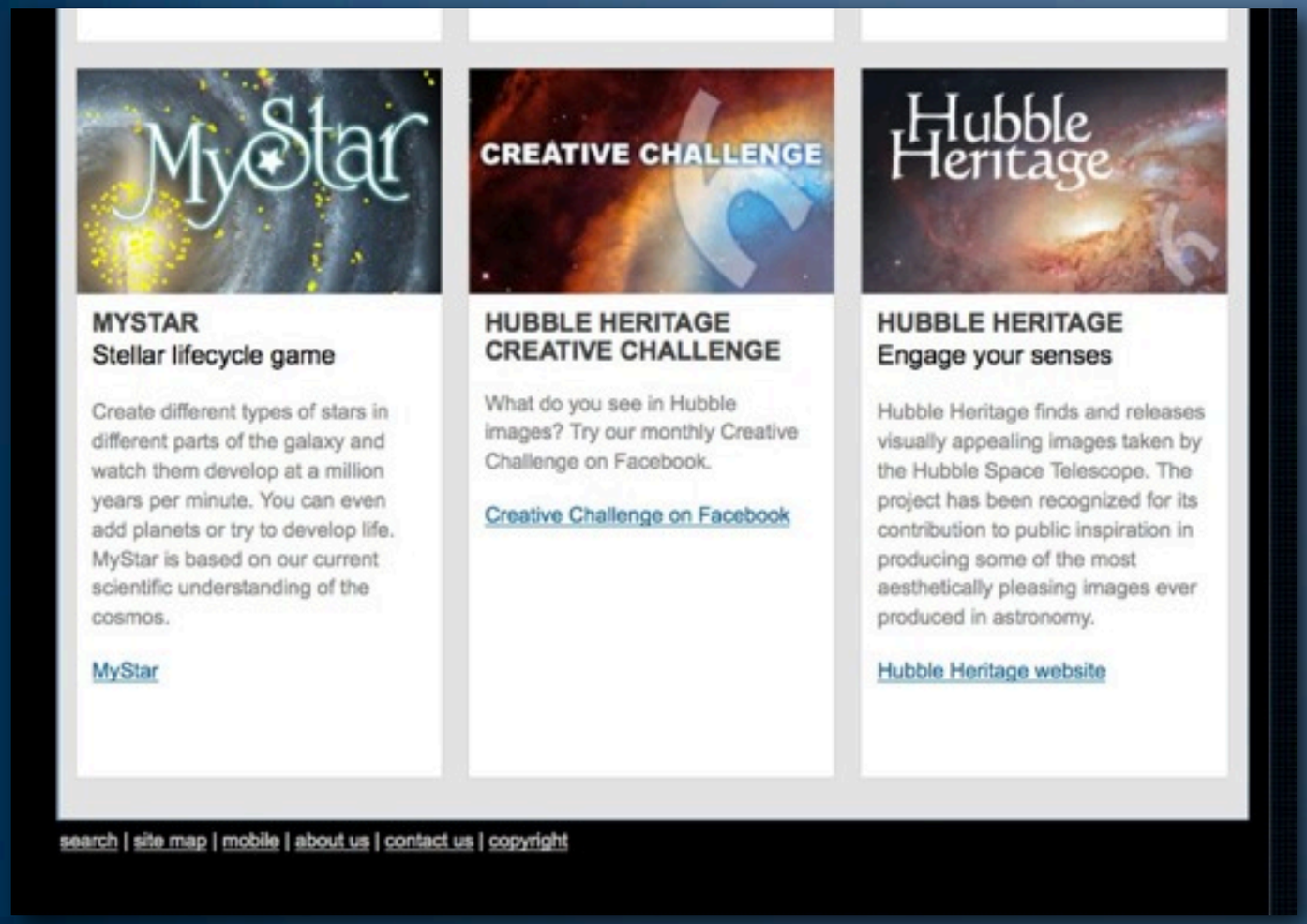
Enthusiasts try their hand at processing HST data for visual appeal

….and Citizen Science

hubblesite.org

PUBLIC ENGAGEMENT PORTAL

active participation for image enthusiasts and science interested individuals



Art, science, games

HST observations treated to enhance the visual and artistic nature of the cosmos.

Challenges to artists to create their interpretations of HST imagery

CITIZEN SCIENCE = COLLABORATION

Scientist

News

Outreach

HUBBLESITE

Formal Education

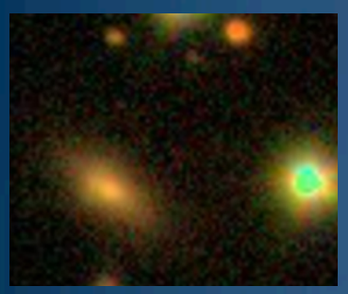
Amazing Space

Informal Education

Public involvement

Education

CITIZEN SCIENCE



Next: citizens collaborate in research

Volunteers perform tasks that contribute to research

Analysis requires large numbers of individuals applying cognitive skills

Studies cannot be performed through algorithms

Outcomes: impact / reach

(metrics and anecdotes)

Increase in refereed research papers

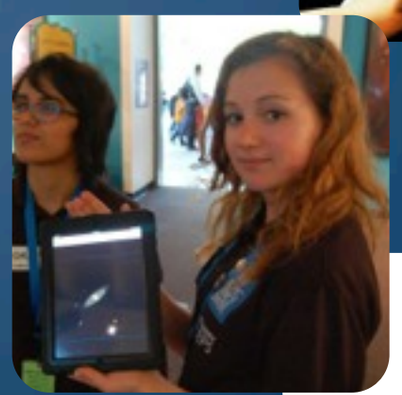
Improvement in machine learning

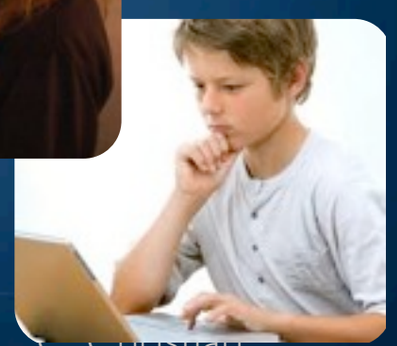
Creation/growth of interested community

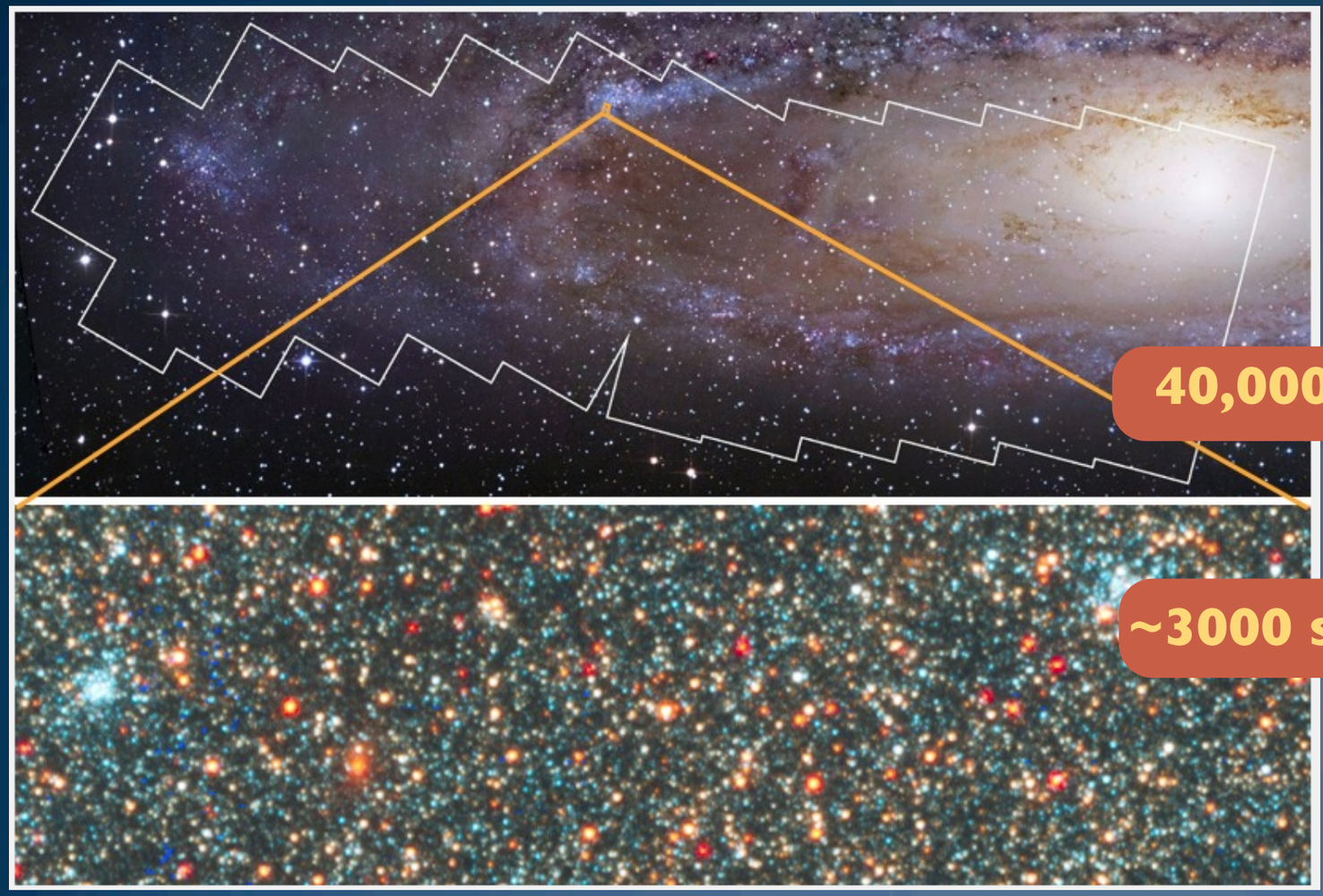
Engage students in the classroom

Build science/technology skills

Case studies, best practices







EXAMPLE:

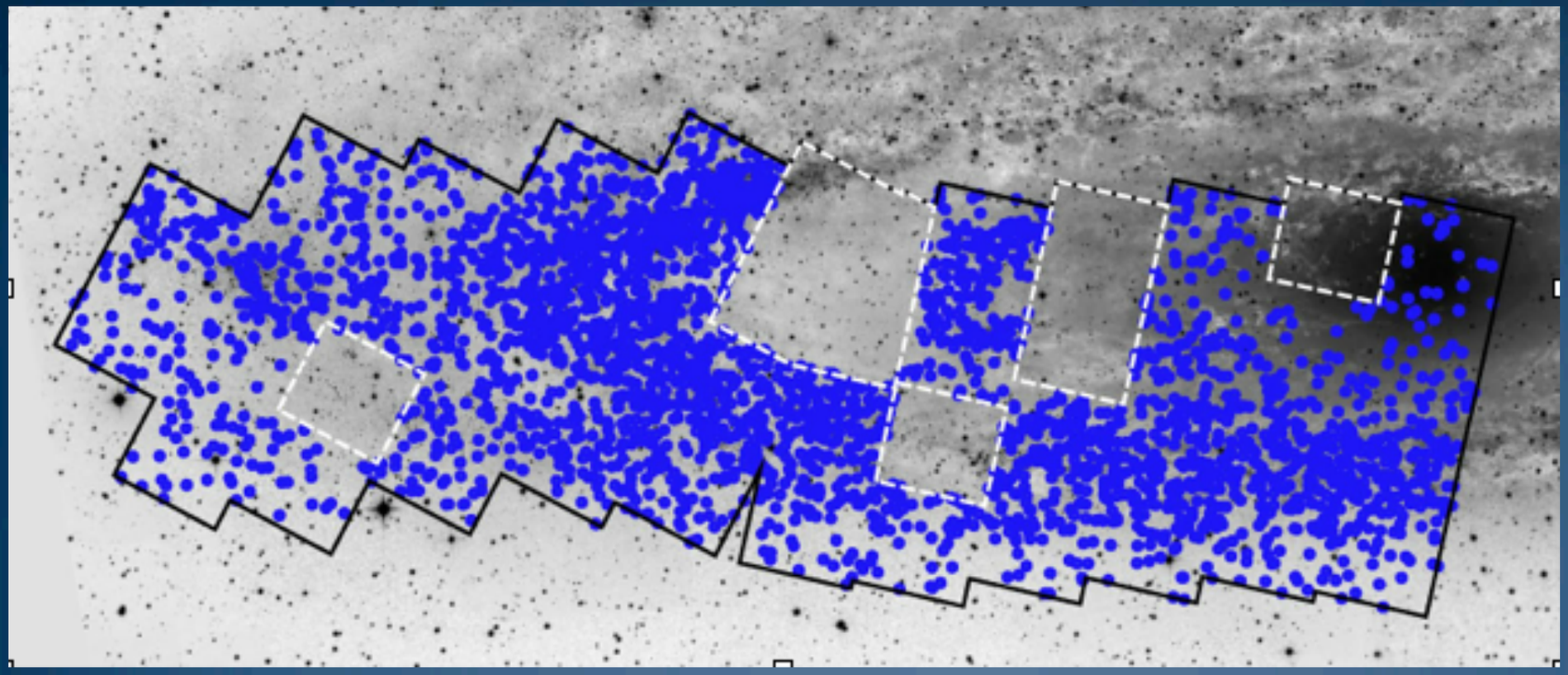
Panchromatic Hubble Andromeda Treasury (PHAT) survey

40,000 separate exposures of M31

~3000 star clusters

the science:

- 8 members on science team
- one month searching the first ~20% of the survey's imaging
- ~600 likely star clusters
- 4x number previously known in same region



the result: launched on December 5th 2012

~7,000 unique visitors examined ~12,000 image cutouts **[reach]**

> 100,000 image classifications in the first day.

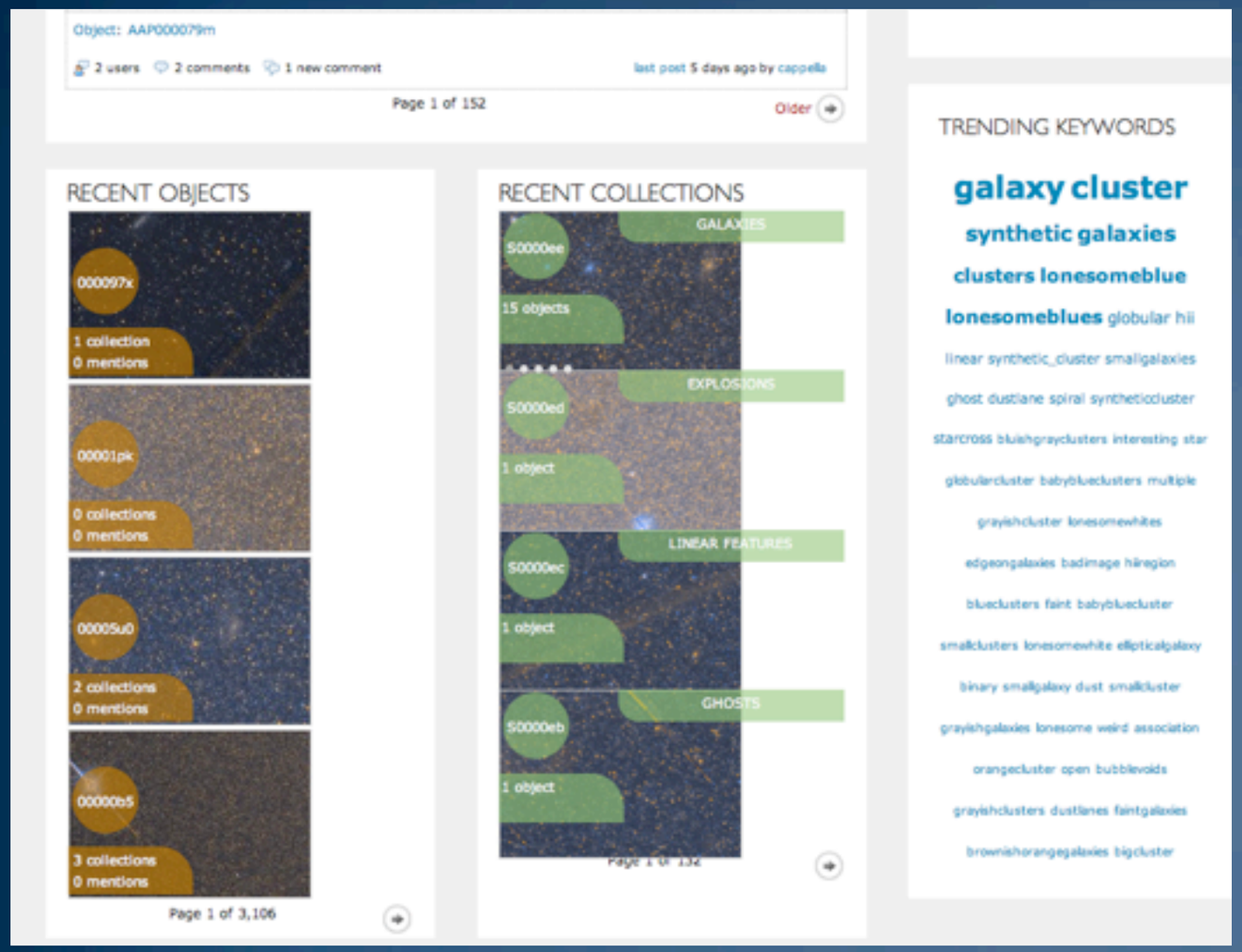
overall classification rate > **one per second!**

after 16 days data collection concludes with > 1 million image classifications

80 individual classifications per image

First research paper January 2013

IMPACT: e.g., "TALK"



Tools

analyze, interact, and collaborate

discuss analysis and results directly with the science team

Example Outcome

Andromeda Project: 18% of volunteers accessed TALK

10% made comments

Snapshot Serengeti: volunteers progressed from assisted classification to recognizing species immediately

Other: volunteers begin to use scientific terminology expressed by science team
[~measurable impacts]

AP Example comments [case study]

...a fair number of the "highly-realistic synthetic clusters" look ...synthetic

...This looks like a possible star cluster... The colors aren't particularly red...there isn't much dust in the cluster... so dust gives off the reddish look, got ya

...could this be a distant galaxy?

SPECIFIC OUTREACH AND EDUCATION OUTCOMES
(we hope)

Interest/enthusiasm/engagement for and in science

Understanding of science and science process

Support of science/technology

Skills

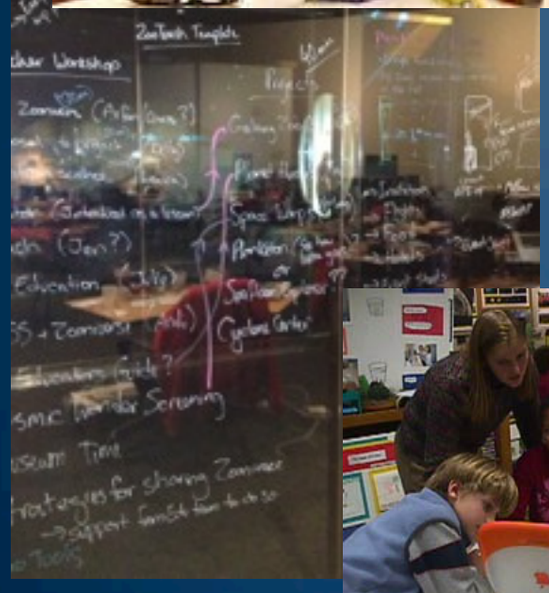
- use of technology
- pattern recognition
- data collection
- data analysis
- data visualization
- interpretation
- independent research
- collaborative research

Education

knowledge, skill, understanding

EDUCATION: FORMAL & INFORMAL

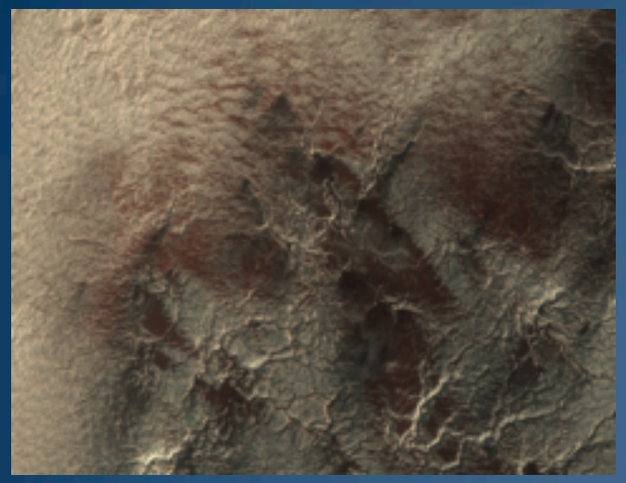
"Students need opportunities to analyze large data sets and identify correlations. Increasingly, such data sets...are available on the Internet."



What can we do?

provide unique content
leverage existing resources
add CitSci tools
engage educators
create partnerships
measure reach and impact

EXAMPLE: School of Physics, Astronomy and Computational Sciences



Planet 4: debris blown out of vents as polar ice melts on Mars

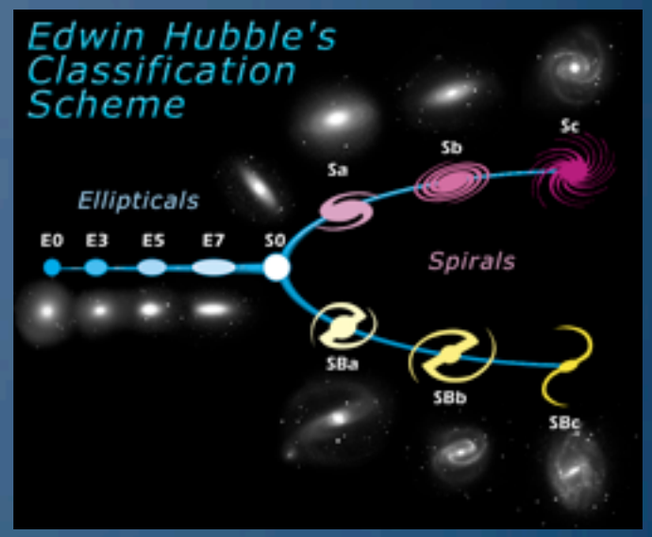
Examine, classify, collect images

Look for patterns

Form a model or hypothesis to explain observations

Test

[case study]



Galaxy Analysis: classify galaxies

Record classifications

Analyze statistics

Compare how groups of individuals classify

Make physical measurements

Explain why analysis by many individuals can create more robust results

[case study]

EXAMPLE: Classroom Supplements

Galaxy Classification:

Use interface
Write 2 pages about what they have learned
Students really like the fact that they are helping 'real' astronomers identify galaxies
Augments understanding the galaxies chapter covered in class **[measurable impact]**

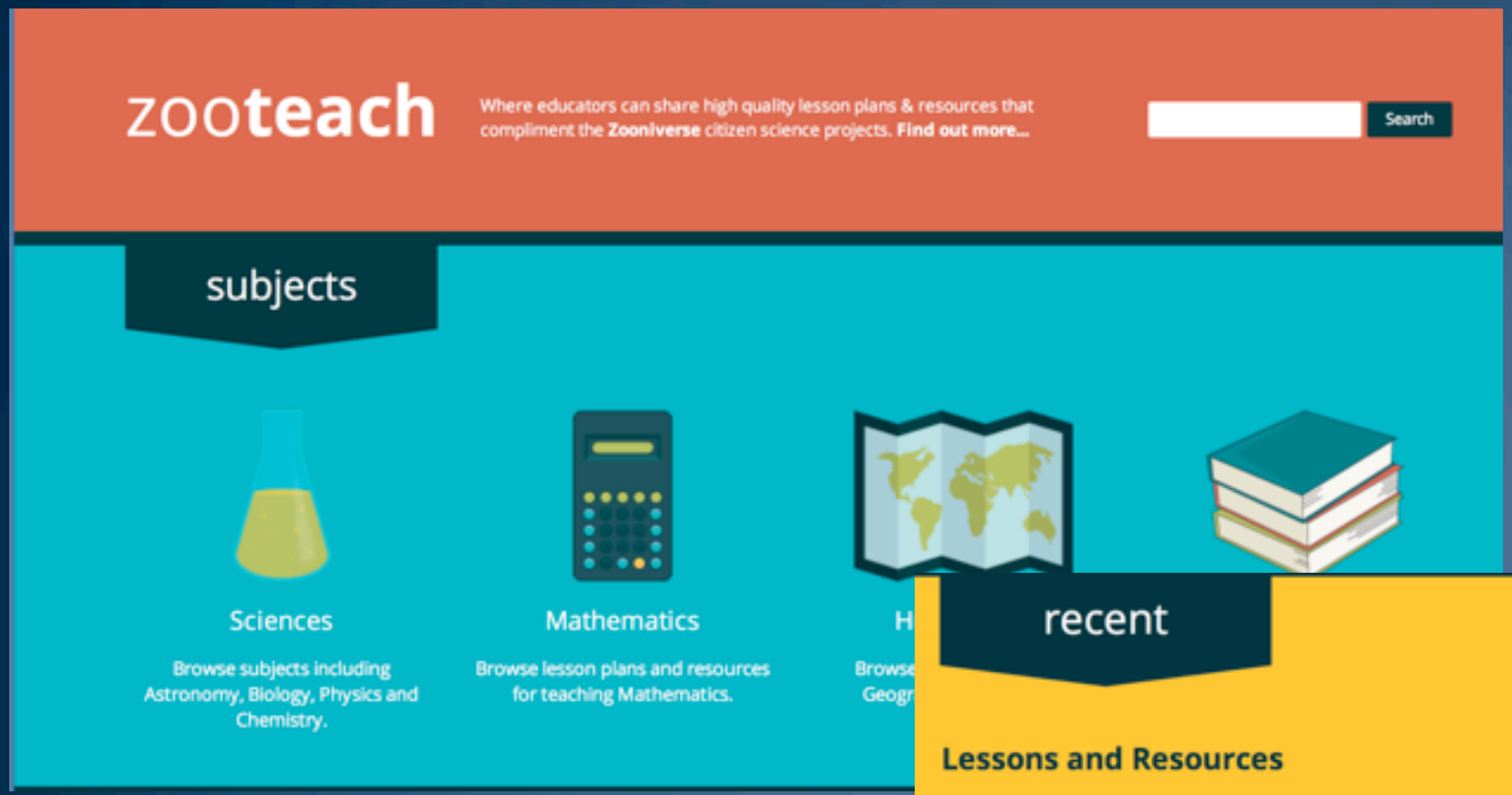
Planethunters, GalaxyZoo, Stardust @ home, NASA's Be a Martian

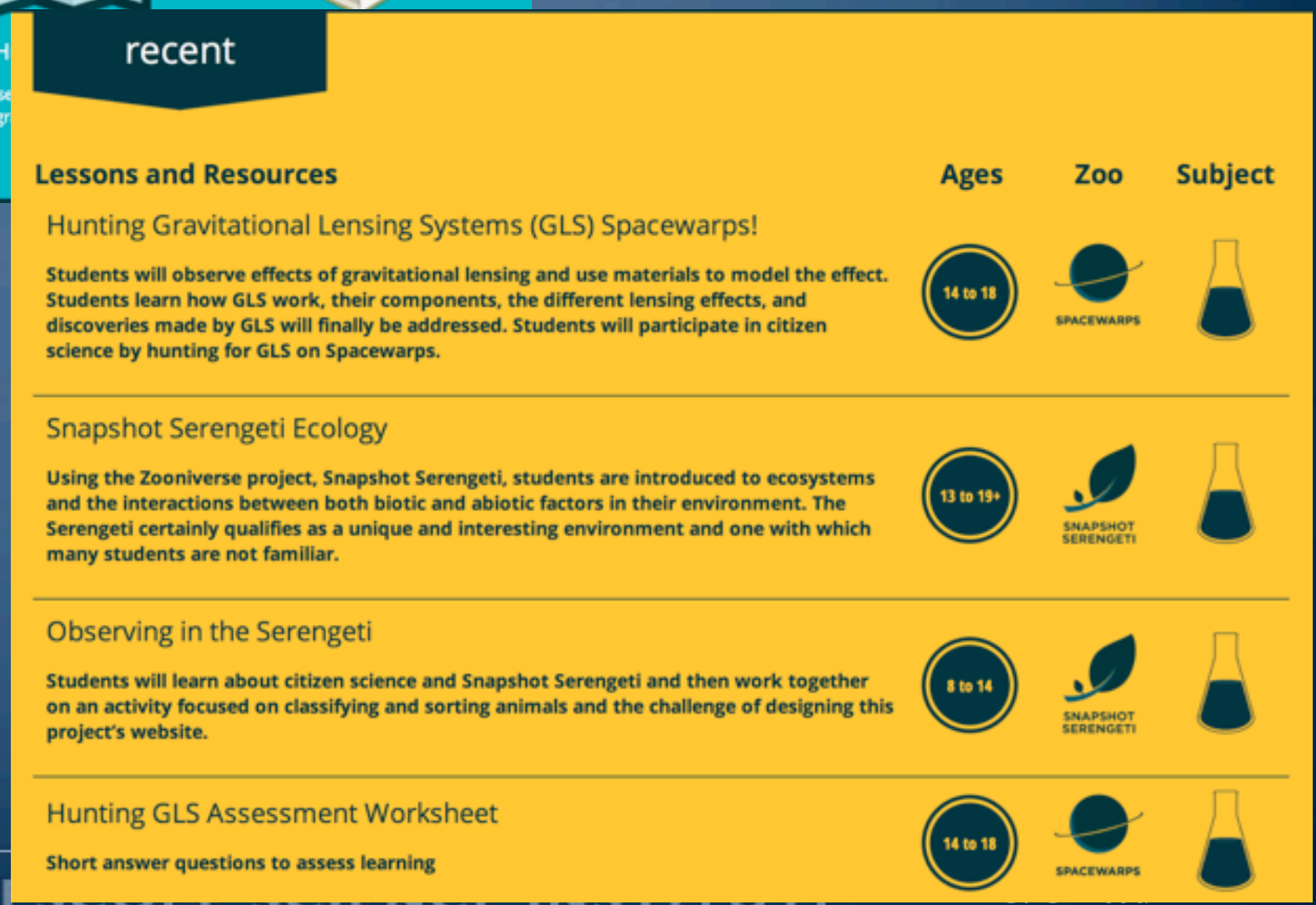
Students select as a part of a laboratory component
Specific activities from each accomplished
Write documentation
Typically students wait until last minute to use the site! **[measurable impact]**

EXAMPLE: **zooteach**

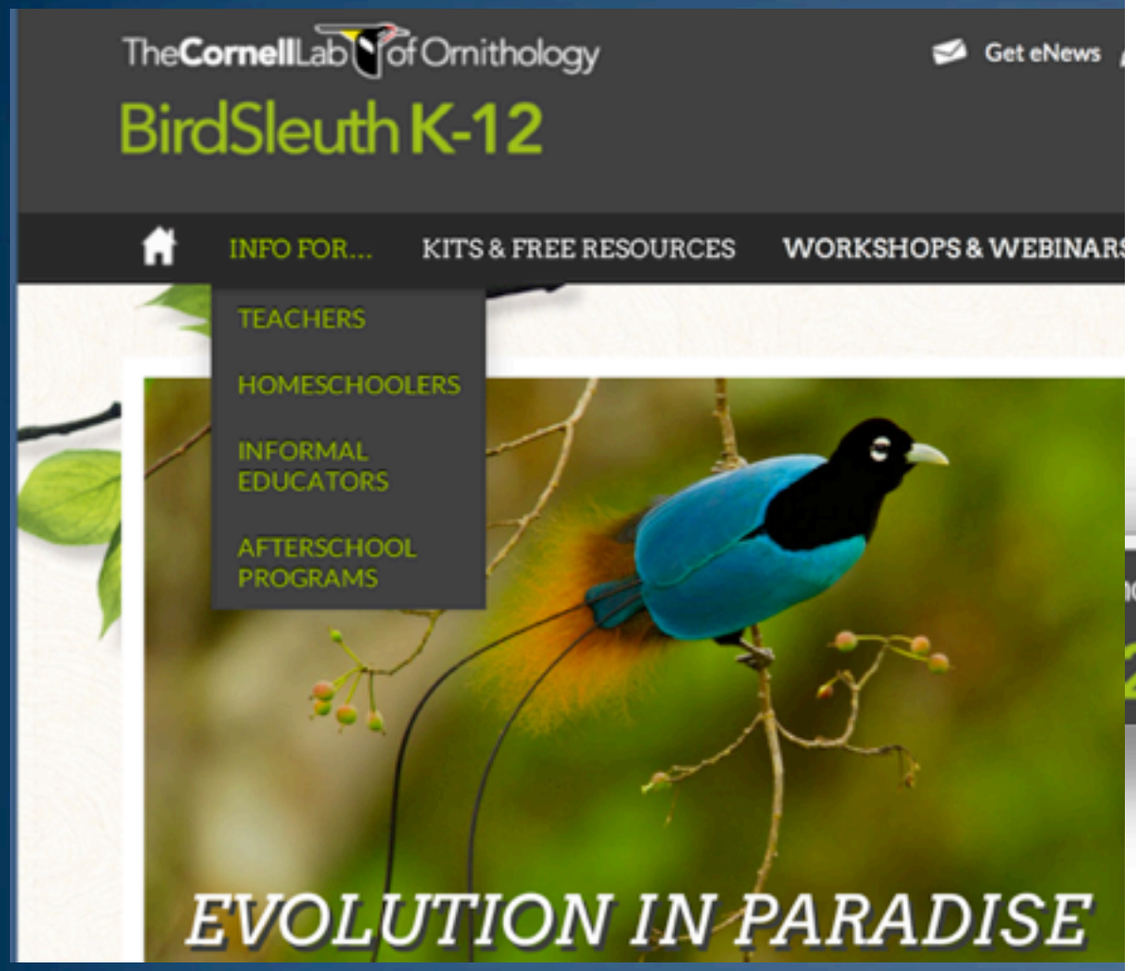
Hassman, et. al 2013, Computer Supported Collaborative Learning (conference).

-skill in collaboration,
-user annotation can indicate skill improvement, or at least deeper engagement





EXAMPLE: BIrd Sleuth



Cornell infrastructure

THE CHALLENGES for the HST PROGRAM

Addressing specific science education standards
Fitting into specific curricula
Specifying learning outcomes
Creating an evaluation plan
Providing and/or linking to existing relevant background and resources

Creating educator resources
Providing data access and collection tools for student tasks
Furnishing example authentic research questions

Measuring "reach" - how many teachers, students, individuals directly involved
Measuring indirect reach - leveraged (e.g., 1 teacher to X students; 1 exhibit to Y visitors)
Evaluating impact, learning achieved, understanding gained

From EDU researchers: "Based on pre- and post-[project] participant surveys, we determined that citizen scientists collected an impressive amount of data and enjoyed the experience but did not achieve the educational goals we hoped for"

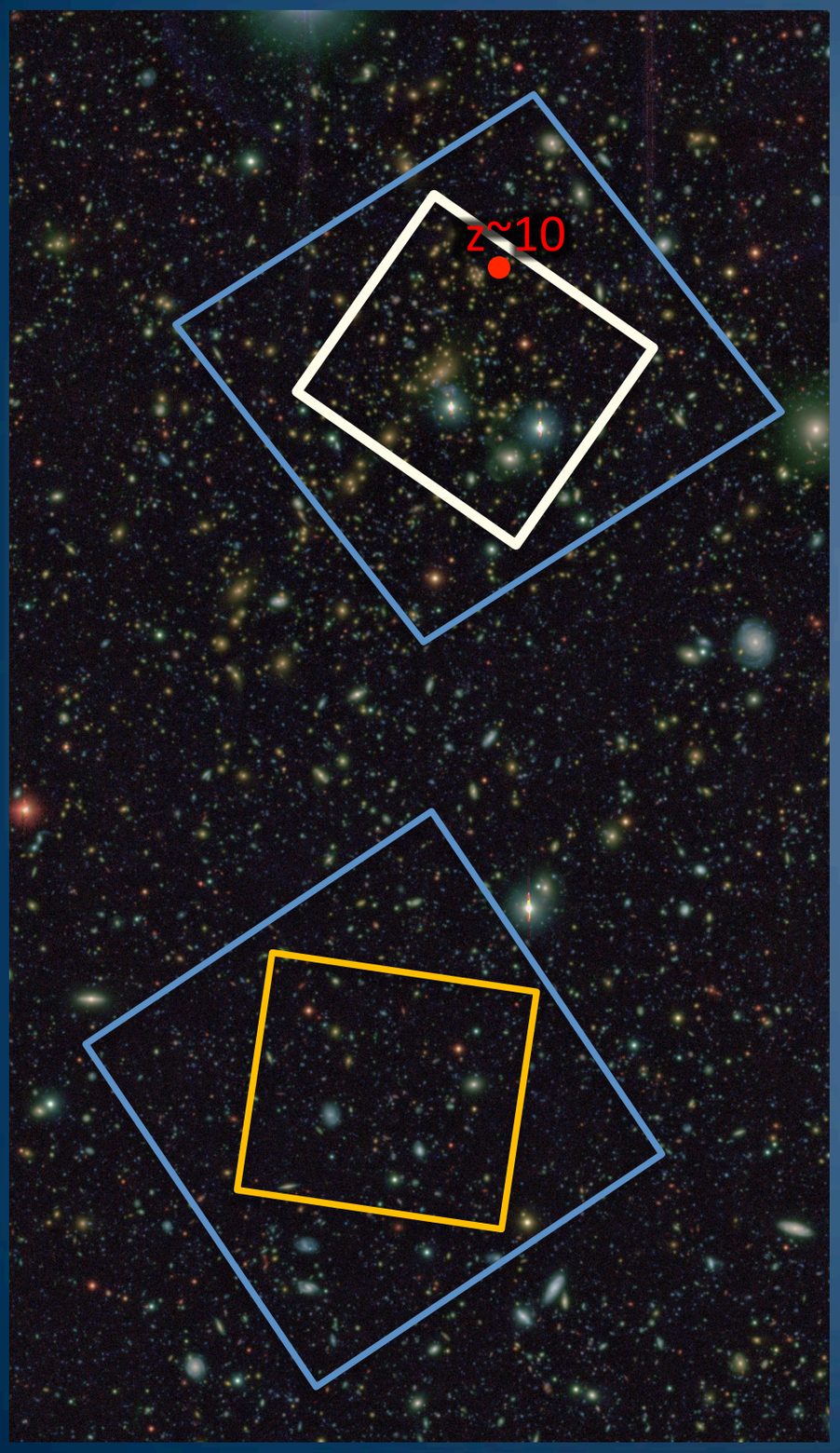
THE HST FRONTIER FIELDS

What will we do?

Citizen Science....

scaffolding....news, educational materials, public engagement,

THE HST FRONTIER FIELDS



intrinsically deepest and widest survey
of the high-redshift universe
(sneak peak at JWST's universe
with Hubble now)

Jennifer Lotz, Matt Mountain,
STScI Frontier Fields Implementation Team

6 strong-lensing clusters + 6 adjacent parallel fields

140 HST DD orbits per pointing
ACS/ WFC3-IR in parallel ~29th ABmag in 7 bands

2 clusters per year x 3 years → 840 total orbits

1000 hours Spitzer DD time for
IRAC 3.6, 4.5 μm ~26th ABmag

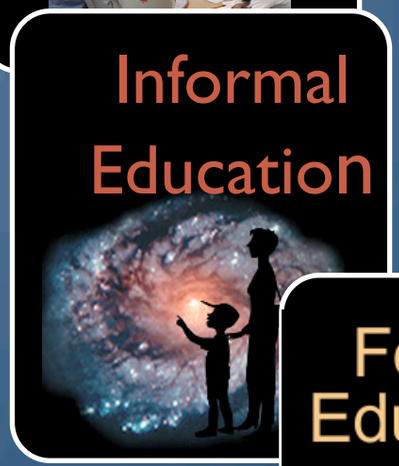
Google: HST Frontier Fields
http://www.stsci.edu/hst/campaigns/frontier-fields/

Science Working Group and Community Input - Science Goals

- galaxies 10-100x intrinsically fainter than any seen before (z~5-10)
- characterize the stellar populations of high-redshift galaxies = the early progenitors of the Milky Way
- enable astrophysics on highly-magnified galaxies at z>=8 (spatially resolved sizes and structures)
- statistical studies of z>5 star-forming galaxy sizes and structures
- detailed maps of dark matter in clusters; test DM substructure predictions
- use 100s of multiple lensed images as independent probe of distance, DE
- deep and high-spatial resolution studies of z~1-4 galaxies study distant transients (SNe, AGN);
- use time delays of multiplied images transients as cosmology probe
- z~10 galaxy counts as a test of DM (rule out Warm Dark Matter?)

FRONTIER FIELDS

Scientist



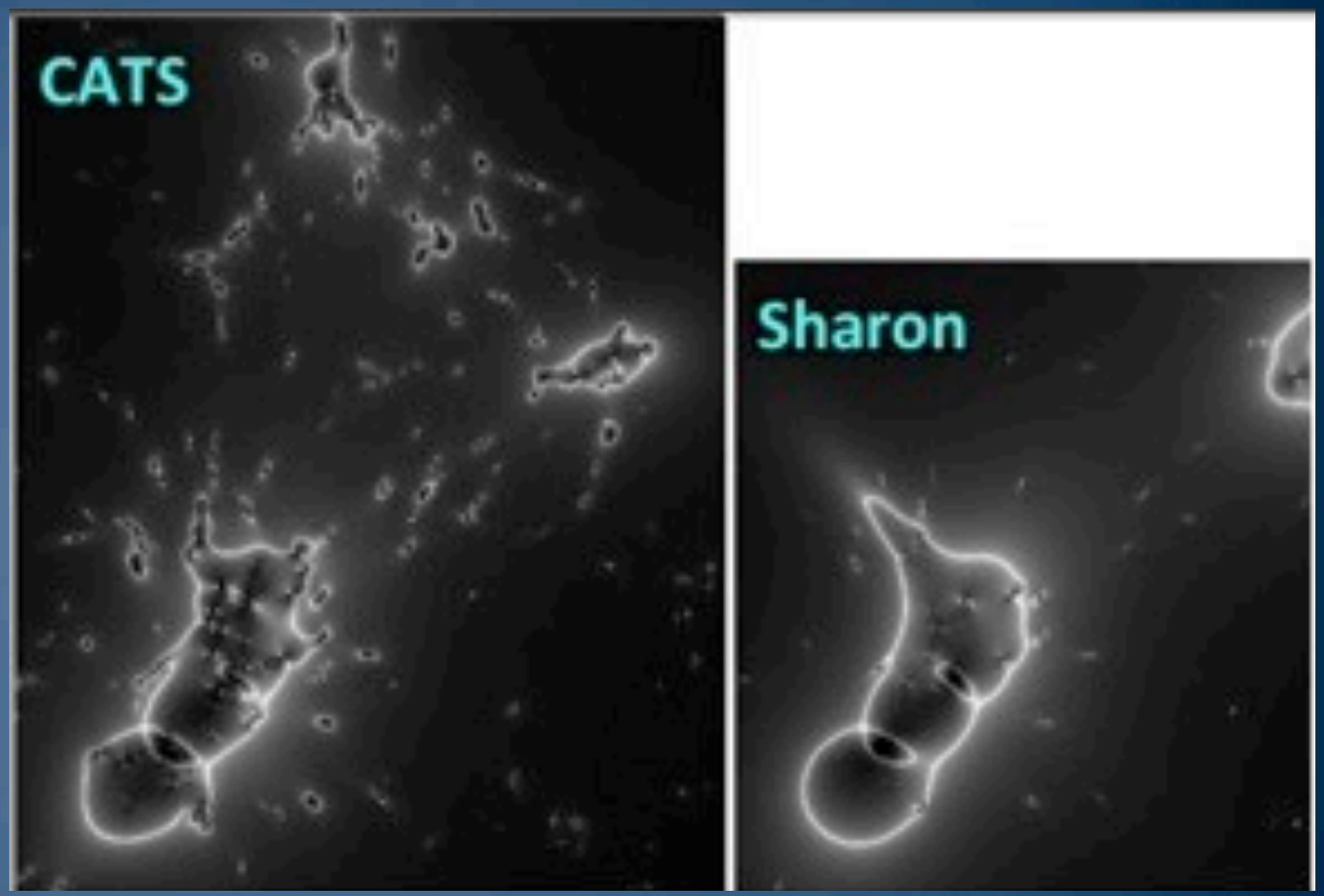
Understand light, optics, and gravity

How does science really work?

Who does science? (me)

How can I get involved?

THE CITIZEN SCIENTIST TASKS



Find the lensed object fragments

Match pre-made models ?

Adjust models to fit data ?

TIMELINE – CORE EDUCATION & OUTREACH COMPONENTS


THE STAR★WITNESS

A PUBLICATION OF NASA'S "AMAZING SPACE" EDUCATION PROGRAM

Special Feature

Albert Einstein: A Genius, Relatively Speaking

By NASA's Amazing Space reporters
September 2006

ALBERT EINSTEIN (1879-1955) was one of the greatest scientists of the 20th century, an era dominated by science. His theories about how the world works transformed our understanding of the universe. Even as a young child, Einstein was thinking about the world in a way that was different from other children. A toy compass given to Einstein by his father inspired the future scientist. The five-year-old wondered what made the needle always point north.

A creative mind and a love for mathematics and physics inspired the German-born Einstein to

Fall 2013

Star Witness News (science process)
Professional Development – formal education

Spring 2014

Hubble Frontier Fields – intro video
Star Witness News (science content reading)
Hands-on Activity - Demonstrations
Professional Development – Hubble Science Briefing, formal education
Outreach - Local/clubs/afterschool

Fall 2014

AAS Poster (January 2015 AAS)
Professional Development - Hubble Science Briefing, formal education
Outreach – Public Lecture Series, local, clubs, afterschool
Lithograph

Spring 2015

Online Interactive – Hubble Deep Field Academy Module
Professional Development – formal education
ViewSpace – Galaxy Evolution
Outreach – local, clubs, afterschool

CitSci RESEARCH PROJECTS based on HST & MAST (archive)

- Galaxy Zoo Hubble: Distant galaxy morphology
- Galaxy Zoo 3: HST MCT CANDELS HST data - SN search
- Andromeda Project: part 1, II of MCT PHAT HST data - identify clusters in M31
- Planet Investigators HST archive data - moving targets in solar system
- Space Warps: CFHT and perhaps future HST data - find lensed objects
- Pinwheel Parts: M83 HST data - classify clusters by age (development)
- PlanetHunters: Kepler MAST data - identify planet candidates and other variables
- Galex Transients: Galex MAST data - identify transients (in planning)
- Frontier Fields: HST data - identify parts of lensed objects (planning)