Kids Capture Their Universe
DRAFT evaluation report for period 12/2005 – 10/2008
10/14/08, mh

Introduction:
The "Kids Capture Their Universe" after-school program was developed, beginning in December 2005, as a collaboration between the MIT Kavli Institute for Astrophysics and Space Research (MKI) and the Harvard-Smithsonian Center for Astrophysics. The initial test locations and pilot testing took place as part of the Citizen Schools after-school organization, at middle schools around the Boston area. The apprenticeship--10 sessions at 1.5 hours each--is run by an astronomy expert volunteer, in partnership with a Citizen Schools staff member.

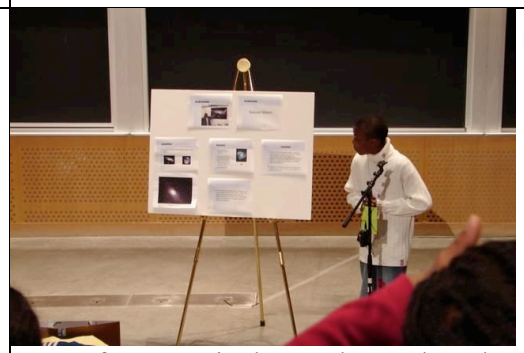
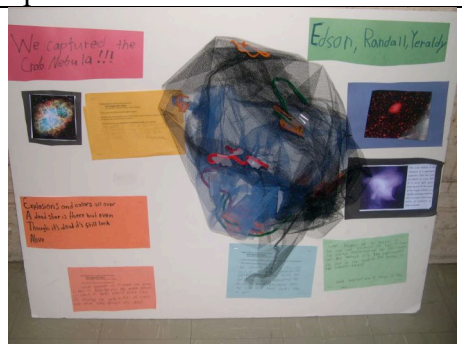
Youth participants will learn how to interpret both images and written information about several objects in the universe. They'll learn to communicate their understanding about some of those objects using pictures, models, and poems as well as the process of how they "personalized" their image using image manipulation tools similar to those used by professional astronomers.

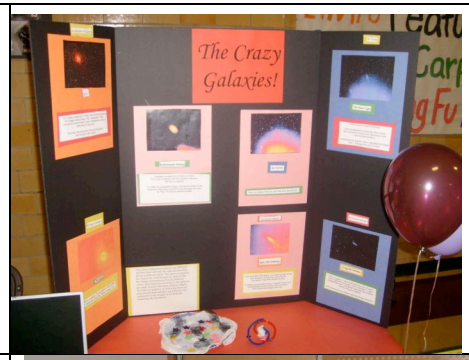
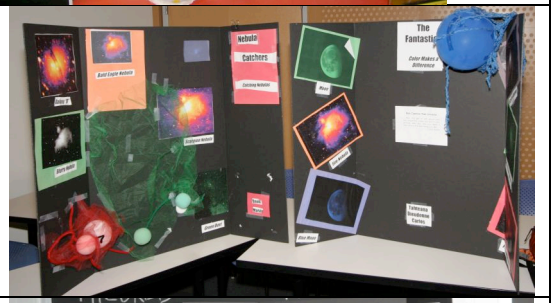
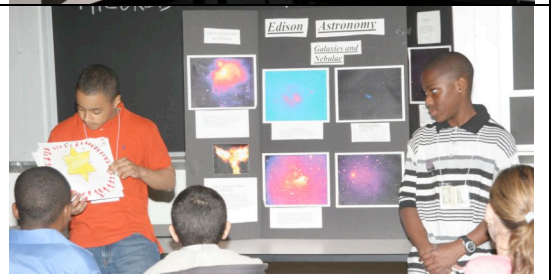
For a final product, called a "WOW," youth will develop and display an astrophotography exhibition of their images, along with poems and/or sculptures related to those images. Students will also demonstrate the use of image processing tools to the audience.

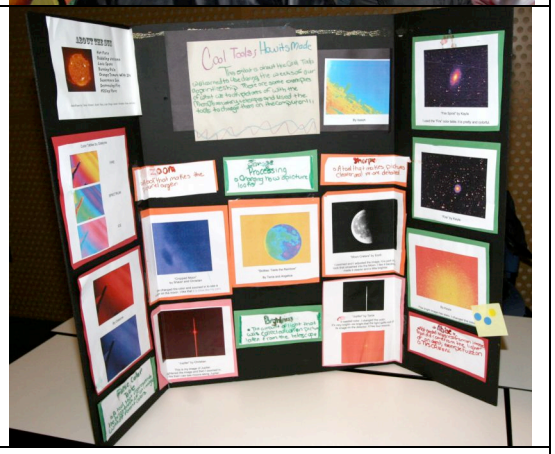
This program was piloted and revised in 3 Citizen Schools locations, field tested in an additional 4, and is currently in use at 4 additional locations in Fall 2008. This report summarizes some of the important changes implemented in KCU as a result of formative feedback over this time, as well as results related to the intended outcomes of KCU for both the youth involved and the astronomy expert volunteers.

Outputs and formative feedback:

Outputs: When and where did KCU happen, and what was produced?

Semester	Location (middle schools)	Citizen Teachers (volunteers) and affiliation	# of students served	Funding source	Typical WOW product example
Spring 2006	McCormack (Dorchester)	• Mark Hartman, MIT, KCU developer • Erika Reinfeld, Harvard, KCU developer • Irene Porro, MIT, KCU developer • Mary Dussault, Harvard, KCU developer	Start = 7 Mid = 7 End = 7	None, performed as a test of what could be accomplished with middle school students in space science.	 How far away is the Andromeda galaxy? Naquan uses 20 CDs as a model.
Spring 2007	Gavin (South Boston)	• Mark Hartman, MIT, KCU developer • Erika Reinfeld, Harvard, KCU developer	Start = 7 Mid = 13 End = 11	Chandra EPO Cycle 8 grant	

Fall 2007	Wilson (Dorchester)	• Mark Hartman, MIT, KCU developer • Erika Reinfeld, Harvard, KCU developer	Start = 9 Mid = 7 End = 6	Chandra EPO Cycle 8 grant	
Spring 2008	Mildred (Mattapan)	• Amateur astronomer • Undergrad science student, Boston University, former student in MKI high school program	Start = 10 End = 9	None	
Spring 2008	Edison (Brighton)	• MIT grad student, aero/astro • Northeastern grad student, mechanical engineering	Start = 10 End = 6	None	 Onassis presents a model of a star from a flip-book as a balance between gravity and outward gas pressure

Spring 2008	Gavin (South Boston)	• MIT grad student, aero/astro	Start = 8 End = 7	None	
Spring 2008	McCormack (Dorchester)	• Erika Reinfeld, Harvard, KCU developer	Start = 15 End = 8	None	
Fall 2008	University Park, Worcester	• Amateur astronomer (same as above)	Start = 12	None	
Fall 2008	Edwards (Charlestown)	• Amateur astronomer (same as above) • MIT affiliate, education	Start = 12	None	
Fall 2008	Umana Barnes (East Boston)	• Citizen Schools after-school staff	Start ~14	None	

Fall 2008	Irving (Roxbury)	• Professional astronomer, Smithsonian	Start ~12	None	

Formative evaluation results / changes to KCU:
Based on the formative feedback from personal experience during the first 3 implementations, or site visits and meetings with field test volunteers during Spring 2008, many changes were made to the KCU curriculum. Thus, the initial program offered in Spring 2006 is significantly different from KCU as currently implemented. Below, we list the issues and lessons learned or subsequent changes/revisions that were made to KCU as a result.

McCormack, Spring 2006

Issue / problem	**Lesson learned or subsequent change/revision to KCU**
Implement KCU with 4 astronomy education professionals	Tried to do too much, not feasible for a single volunteer to handle.
Maintaining student focus on questions hard to do with only one contact with scientist during field trip	Questions should come up in relation to images, and guided toward what students can realistically find out.
options for projects were too open	Reduced number of possible projects: exhibit, with smaller choices of creative element to add on.
Youth felt disconnected from images, that image processing was a secondary focus of apprenticeship	Focus more on image processing and working with those images.
Sharing resources between volunteers and Citizen Schools staff was hard week to week	Implementation of a website via Moodle, an open-source "course implementation tool" to share resources and plans
*Exhibits ended up being developed by individuals, not teams	KCU needs more teamwork to be built in.
Positive effect of peer feedback on student interaction	Maintain specific structures for written and oral peer feedback.

Gavin, Spring 2007

Issue / problem	Lesson learned or subsequent change/revision to KCU
*Teamwork was hard to develop when formed teams later in the apprenticeship	Maintain consistent focus on teamwork from beginning of apprenticeship, including opening games
Many youth joined apprenticeship in later weeks.	Need to make each lesson self contained: i.e. work on one topic per week to be added to final WOW product.
Student ownership of their images and interest in others' images to be included in WOW exhibit both at low levels.	Incorporate peer voting on image favorites in week 6: each student reviews all other images, choosing favorites and using results to choose his/her own images for WOW product.
Image taking still felt a secondary focus. Shown by strong use of professional images instead of youth-processed images in final exhibits.	Must strongly incorporate image processing into apprenticeship: shift focus from astronomy exhibit to "astrophotography" exhibit.
Too much content without a strong organizing principle (i.e. hierarchy inside/outside solar system, lifecycle of stars, textual information about objects)	Focus on the youth images of objects and their appearance as the organizing principle of apprenticeship. How is the appearance of this object linked to its function?

Wilson, Fall 2007

Issue / problem	Lesson learned or subsequent change/revision to KCU
Issues with reliable computer access	Revise listing of technical requirements to make more simple and available before choosing apprenticeship sites
*Realize that content comes through vocabulary and the connection to images.	Print out vocabulary words and definitions to have a physical presence in the room.

Edison/Mildred/McCormack/Gavin, Spring 2008:

Issue / problem	Lesson learned or subsequent change/revision to KCU
No clear connection between different images, and youth had trouble remembering what they learned about images week-to-week.	Incoporate an "image wall" in the room for public display/recognition of good images and accompanying captions.
Larger group of volunteers wants to share ideas with each other	Offering a mid-apprenticeship and end-of-apprenticeship feedback meeting to share ideas and challenges.
Processing activities seem to allow students to wander if there is no clear, specific goal	Recast processing activities into "processing challenge" form: instructor demonstrates a tool, then gives youth 2 novel final images to recreate using that tool.
*Peer review was still difficult at end of apprenticeship and writing captions is difficult to motivate	Incorporate peer (team) work with images and caption development (i.e. one member creates, one member interviews and writes caption) Public display of caption work in image wall.
*Content gets lost or disconnected from vocabulary words or images	ALWAYS connect ideas/questions/content back to the images processed, giving extra recognition to vocabulary used correctly in captions.

*Those changes/revisions marked with an asterisk indicate those that directly impact the current intended outcomes of KCU, see next section below.

Astronomy in the City WOW event attendance:

At the end of each apprenticeship, youth normally have two chances to present their astrophotography exhibit. One event takes place at their school, to showcase all the apprenticeships at that school. The other event is meant to allow youth to share their learning with the wider community, including professionals in that field. In the case of KCU, this event has been "Astronomy in the City" (AIC), a showcase of the work of all middle and high school students in MKI out-of-school time programs. This event allows students to share with peers, community and professionals at MIT. See table below for information about each AiC event in relation to KCU.

Semester, date of AiC	# of KCU students at end of apprenticeship	# of KCU students attending AiC	Format of AiC
Spring 2006; May 13, 2006	7	4	Saturday, 3pm - 6pm
Spring 2007; May 12, 2007	11	1	Saturday, 1pm – 5pm
Fall 2007; December 7, 2007	6	6	Friday, 6:30pm – 8:30pm
Spring 2008; May 16, 2008	30	~19	Friday, 6pm – 8:30pm

As the apprenticeship developed, the participation in this event steadily increased, as we responded to two influences: (1) the need to advertise the event and make sure that students felt they were contributing to their WOW presentation each week, and (2) the needs of parents and Citizen Schools staff for a shorter evening event instead of a Saturday event. However, in most cases, the Citizen Schools staff member arranged for transportation to these events, with a minimum of parents involved. Parents were more likely to come to the WOW event held at the school.

Intended outcomes for youth participants in KCU:

Although the particular desired student outcomes for the KCU program changed as we refined the program, there are several pieces of evidence that can be related to the current outcomes of KCU outlined below. These are drawn from the "New Basic Skills" that Citizen School emphasizes, and the KCU curriculum is designed around them.

1. Teamwork: Students are able to contribute to group work while sharing the "spotlight."
2. Advanced Literacy: Students are able to correctly apply terma sn vocabulary associated with the Apprenticeship.
3. Leadership: Students are able to speak more confidently in front of an audience.

Most of this information was gathered through a survey that was given near the beginning and end of the apprenticeship, with some locations also administering a survey midway through the apprenticeship.
For the results shown below, pairs of results indicate pre and post surveys, while 3 numbers represent the addition of a mid-point survey. In some cases, the comparison groups of students are matched pairs. However, due to small numbers and the changing enrollment of the apprenticeships, most results indicate the entire group that was present on the day the survey was given.

Teamwork:

Students were asked to choose words from a list that came to mind when they thought about "doing science in the astronomy apprenticeship." One of these descriptors was "group work," and the percentages of students choosing that response is shown in the table below.

Group and number	Pre-survey	Mid-survey	Post-survey
McCormack, Sp06, N= 7,7, matched pairs	43%	57%	
Gavin, Sp07, N= 7,12,9	29%	33%	44%
Wilson, F07, N=6,6,5	50%	67%	60%
Mildred, S08, N= 10,7	20%	29%	
Edison, S08, N=10	20%		
Gavin, S08, N=8, 5, 2	50%	60%	100%
McCormack, S08, N=15, 5	0%	20%	
University Park, F08, N=12	41%		
Edwards, F08, N=12	41%		

In general, we see a pattern of increasing response rate, although it must be noted that the only matched pair group is the McCormack and Wilson groups. In addition, the Wilson, F07 group was asked on the post survey if they were "proud of their work on the WOW exhibit", with 4 of 5 students indicating strong agreement. This is relevant, as the projects were mostly group work. The Wilson group was probably the best at the teamwork aspect, possibly because they were a small group.

Applying vocabulary correctly:

In later apprenticeships, students were asked to "list words you'd use to describe or tell about this object" along with an image of either the moon, Crab nebula or Andromeda galaxy. We coded these results, indicating whether students used specific KCU vocabulary (i.e. moon, nebula, galaxy, crater, etc.) correctly, incorrectly or simply used other descriptive words ("shiny", "spinning", "big", etc.). No particular directive to use KCU vocabulary was imposed on the students. Results are shown in the following table. Note that this activity was not added until Fall 2007. The Wilson group identified words with these pictures as a group during a few early sessions as a warm up, and not in survey form, so the number of students present in the room and generating descriptive words may not always be 6 for the 3 objects. However, there were only 5 students who took the post-survey, where the three images were presented together.

Group and number	Pre-survey: # of correct uses of vocabulary / # incorrect uses of vocabulary	Mid-survey # of correct uses of vocabulary / # incorrect uses of vocabulary	Post-survey # of correct uses of vocabulary / # incorrect uses of vocabulary
McCormack, Sp06, N= 7,7, matched pairs			
Gavin, Sp07, N= 7,12,9			
Wilson, F07, N=6, 6, 5	Moon: 1 / 2 Crab nebula: 1 / 0 Andromeda galaxy: 1 / 3		Moon: 2 / 0 Crab nebula: 1 / 1 Andromeda galaxy: 2 / 0
Mildred, S08, N= 10,7		Andromeda: 4 / 0	
Edison, S08, N=10			
Gavin, S08, N=8, 5, 2	Andromeda: 1 / 3	Andromeda: 2 / 0	Andromeda: 0 / 1
McCormack, S08, N=15, 5	Andromeda: 4 / 3	Andromeda: 3 / 0	
University Park, F08, N=12	Andromeda: 2 / 1		
Edwards, F08, N=12	Andromeda: 1 / 4 (called it "Milky Way"		

Although there are no clear patterns, we do see a stronger likelihood to not have actively incorrect application of terms in the middle and end of the apprenticeship.

Leadership / oral presentation confidence:

Students were given the following question:

> Imagine this situation: You have just completed a project with a group of other Citizen Schools students. You are all about to get up in front of a group of 25 of your peers to describe what you've done as part of a "teach back."
>
> 1. Place an "X" somewhere along the scale to indicate how you would feel at that moment:
>
> I do not feel comfortable. ____ ____ ____ ____ ____ I feel comfortable.

We coded students responses to this question on a 5 point scale, with 5 corresponding to "I feel comfortable." The median values for each group is given below:

Group and number	Pre-survey:	Mid-survey	Post-survey
McCormack, Sp06, N= 7,7, matched pairs			
Gavin, Sp07, N= 7,12,9			
Wilson, F07, N=6, 6, 5	3.5	5	5
Mildred, S08, N= 10,7	2		
Edison, S08, N=10	3		
Gavin, S08, N=8, 5, 2	4		4
McCormack, S08, N=15, 5	3		
University Park, F08, N=12	3		
Edwards, F08, N=12	4		

Because the data collection is not complete for most locations, it is hard to determine if there is a positive pattern. However, the experience at the Wilson school in Fall 2007 shows a positive change, which could be attributed to the good experience of the students

in presenting their work to high school students, the general public and professional astronomers at "Astronomy in the City" in December 2007.

Additional possible outcomes / attitudes toward work in the KCU program:
As mentioned above, youth were asked to choose descriptive words from a list that came to mind when they thought about "doing science in the astronomy apprenticeship" on most of these survey instruments. Below, we list the descriptors that 50% or more of the youth responding to a given survey chose. This is an indicator of the overall response of the group to the apprenticeship. Descriptors listed in green represent new additions over the descriptors chosen in the previous survey. Blank entries indicate no results are available.

Group and number	Pre-survey:	Mid-survey	Post-survey
McCormack, Sp06, N= 7,7, matched pairs	Interesting, fun	Creative, group work, interesting	
Gavin, Sp07, N= 7,12,9	Creative, fun	fun	Interesting, fun
Wilson, F07, N=6, 6, 5	Challenging, group work, fun	Working alone, easy, important to me, challenging, group work, fun	Easy, important to me, challenging, understandable, group work, fun
Mildred, S08, N= 10,7	none	Fun	
Edison, S08, N=10	Creative, fun		
Gavin, S08, N=8, 5, 2	Easy, creative, challenging, group work, interesting, fun	Frustrating, group work	Group work
McCormack, S08, N=15, 5	None	Easy, creative	
University Park, F08, N=12			
Edwards, F08, N=12			

Overall the most likely descriptors to be added (in two cases each) are creative and easy. Although neither of these descriptors are directly related to our New Basic skill outcomes, part of the design of KCU includes science as a creative endeavor. We may also take the addition of "easy" to mean that students may have been concerned that a "science program" would be overwhelming, but did not turn out that way, giving us an indication that students had a positive experience. Of particular note is the indication by the Wilson group in Fall '07 that "doing science" in the astronomy apprenticeship is "understandable."

Intended outcomes for astronomy expert volunteers in KCU:

Of additional importance is the feedback received from volunteers who had been trained to run KCU. During Spring 2008, 3 of the 4 apprenticeships were run by astronomy expert volunteers in addition to the Citizen Schools staff member. Overall, 5 astronomy expert volunteers were involved, with 2 sites having a pair of volunteers.

There are two main outcomes relating to the attitudes and ideas which we hope the KCU experience will affect in our astronomy expert volunteers:

1. Astronomy experts view science out-of-school programs (and KCU, in particular) as important for youth because they support the development of teamwork and communication skills, in addition to science content knowledge.
2. Astronomy experts view education and outreach as realistically possible, given their other commitments.

A survey of the astronomy expert volunteers was given at the end of the Spring 2008 apprenticeships. Several questions were asked which relate directly to the two outcomes above. 3 of 5 volunteers returned these surveys. Responses are coded as follows: A = Amateur astronomer at Mildred, B = Astronautics grad student at Gavin, C = Mechanical engineering grad student at Edison.

Views on why KCU is important for youth:

What were some of the valuable things your apprentices got out of being in KCU? How could you tell? (i.e. what did they do or say or how did they act differently toward the end?)

A: We got tons of positive (and some written) feed back from the kids as we approached the WOW! but only a few participated in it. Really chickened out. Practicing presentation seemed to have no effect on the extreme level of reluctance to speak in front of others! The youngsters who did participate really overcame their nerves, the gritting of teeth could be heard in Medford !
I will tell you very honestly that the WOW! experience has changed them - all positive, of course. Both in over coming their fears and in the appreciation expressed by their peers and classmates ! Again, do the school WOW!
My kids missed the Idol Competition at MIT...shame but OK. I was really looking forward to that opportunity for them too

B: I think they definitely feel less intimidated about Astronomy. One student even went out and bought an Astronomy book and brought it to the apprenticeship for discussion. He was asking lots of tough questions, some of which I didn't know the answers to. I think they also have a deeper understanding for the teamwork involved in science/astronomy, and the reasons

why it is important. They asked lots of questions about why a telescope is so hard to make and why it requires so many people to work on it.

C: They got some space knowledge and some presentation skills.
(Next response is from another question about WOW preparation) We had them run through the presentation twice on the last day. They were eager and nervous, we made a few comments while they presented (don't stand in front of the board, speak up, etc.) and they picked up these notions very quickly.

Note that in all three cases, the volunteers explicitly mention teamwork or presentation skills, showing that they acknowledge the design of the KCU as a way to foster these skills. In the case of the two grad students, they also mention the development of science skills and content knowledge. It is a bit surprising that the amateur astronomer (A) did not explicitly mention this, but really believes that the real value was in "overcoming their fears and in the appreciation expressed by their peers and classmates." These statements may not be surprising, given that we emphasized the development of these skills in the KCU training and site visits made by program designers, but it does show that these efforts were enough to convince volunteers of their importance.

View education and outreach as realistically possible for them, given other time commitments:
What was the most valuable thing you got out of being involved with KCU this semester?

A: I always enjoy working with kids, I always enjoy working with people, so that almost goes without saying. What really intrigued me was the program itself and its goals of self expression, discovery and opportunity. When I first contacted the program I really thought the word WOW! was a little presumptuous...not so..WOW! is the only word that fits !

B: The most valuable thing for me was getting to increase student's interest and awareness in science and math. Specifically, getting to show them "the light at the end of the tunnel". By demonstrating first hand what is possible through science and advanced scientific instruments, such as a robotic telescope and image processing software.
Also, I value my lessons learned in interacting with and teaching middle-school aged students about science.

C: Experience. The ability to see true interest. [of youth]

The response of A reinforces the idea that this volunteer was particularly drawn to the idea of the connection that individual youth can make to science in a creative, self-chosen way.

If you talked with a prospective CT or TL, what about your KCU experience would you say to convince them to be involved? (What would have convinced YOU?)

> A: I was totally impressed with the Citizen Schools philosophy...which I was exposed to most emphatically by attending a luncheon hosted by Ned Rimer - one of the founders. Very positive, very convincing, very impressive !
>
> Picking KCU over another program should follow exactly what you are doing, finding people who are comfortable with the subject material and let it fly !
>
> B: This is my favorite program for giving back to the community. I feel it is an ideal structure for community service. The program cross cuts cultural and age boundaries, builds a sense of community from disparate groups, provides positive role-models and expertise for children outside of their immediate family, and the time commitment is manageable for a busy person.
>
> C: It's rewarding to see kids interested in something and eager to learn/succeed. It's good to be well-rounded.

Note that the response of B explicitly mentions a reasonable time commitment, and the response of C indicates an understanding that being involved is not only personally rewarding, but also useful in a wider sense of being "well-rounded." We can infer that volunteer B also feels that building a "sense of community from disparate groups" is also a valuable personal experience.

Amateur astronomer volunteer case study:
A case study in the motivations and indicators of "buy-in" to the KCU program is the amateur astronomer volunteer at Mildred in Spring 2008. Already a strong volunteer for his own astronomical society and other science out-of-school time programs, this person was very impressed by the quality of the KCU program. Based on his experience, he has returned to run two additional KCU sites in Fall 2008, one in Boston, and one much nearer his home in Worcester, MA. In addition, he has served as contact person for two additional after-school sites where KCU may be brought in the future, the Boys and Girls Club of Leominster/Fitchburg and the Needham science center. Although only one individual, the additional effort put in by this person shows that he believes the program to be a worthwhile outlet for his desire to do outreach, as well as to involve others.