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Grant No. EPS-0236913



Ewing Marion  
KAUFFMAN  
Foundation



# What is Quarked?

Quarked is a physics education project for ages 7 and up

## Funding

- NSF State of Kansas EPSCoR grant
- Kauffman Foundation development grant
- Google AdWords grant



## Project components

- Interactive web site ([www.quarked.org](http://www.quarked.org)) with animated videos, games, lesson-plans, FAQs, glossary, videos, etc.
- Hands on science programs for elementary and middle school students
- Links with QuarkNet, NSF informal science education and other grants

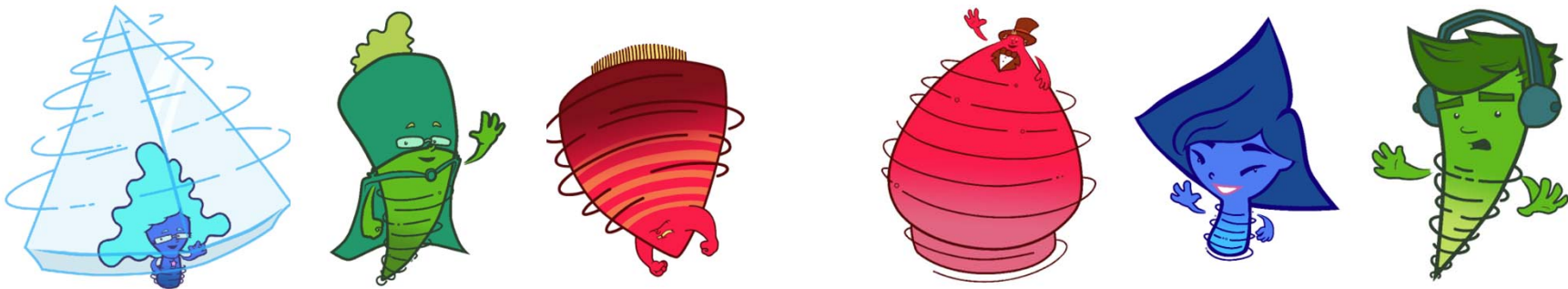


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# Characters & Subatomic Alter-egos



[www.quarked.org](http://www.quarked.org)



# Web – [www.quarked.org](http://www.quarked.org)

> 60 countries

100,000+ visits

## Information

GLOSSARY

LESSON PLANS  
Learning Themes: 1 | 2 | 3 | Glossary

Lesson plans are organized by learning theme and are stand-alone – they can be done in any order.

1. How small is small?
2. Quarks: Ups, Downs, and the Universe.
3. How do you find out about something you can't see?

ask MR. MARKS



## Videos

## Games

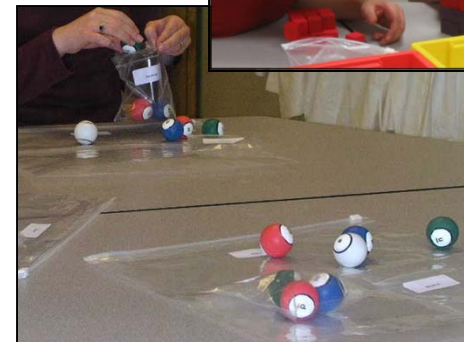
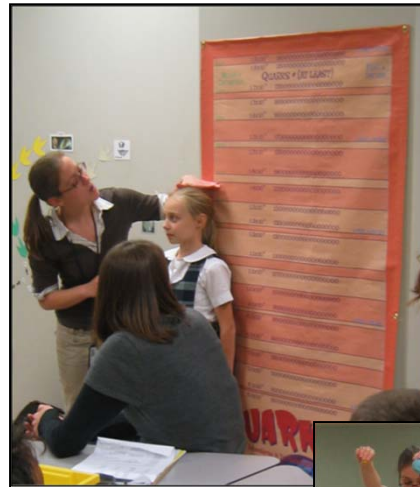




# Education programs

*How Small is Small?* (Grades 2 to 6)

*Quarks: Ups, Downs and the Universe* (Grades 4 & up)



# Example Activities

Down

Charm

Top



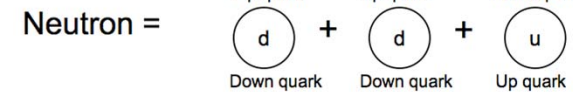
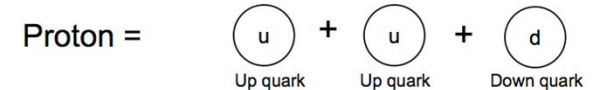
Up

Strange

Bottom

Quark Properties: Density

## How to Build Particles



# of Electrons = # number of protons

The quarks in protons & neutrons must be three different colors:

1 red, 1 blue, 1 green



# Why this age group?



- At this stage young people are open to everything and don't know that physics is hard.
  - » Comment from NSF Early reviewer:  
... already established that developmentally, physics and other abstract concepts are more appropriate at the high school level.
  - » We didn't think this was right!

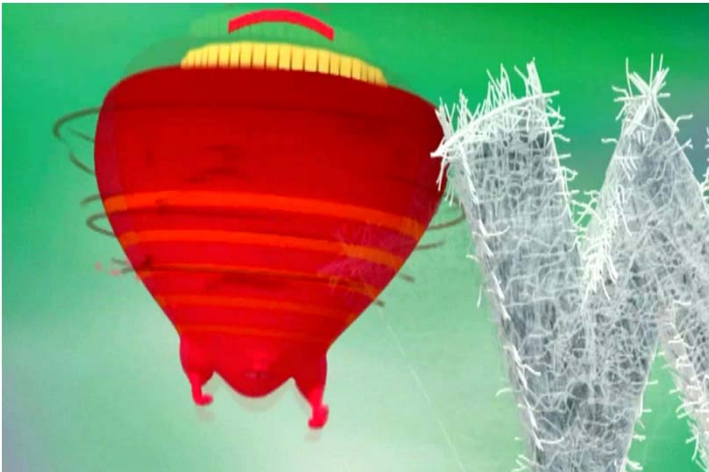




# Can you engage elementary & middle school aged children with concepts related to particle physics?

## Learning Research:

Suggests that concepts of very small scale and the particulate nature of matter are accessible to young learners, and an earlier emphasis might be helpful.



## Pilot Study:

Video assessment

Interview and Participant observation (ages 7-11)

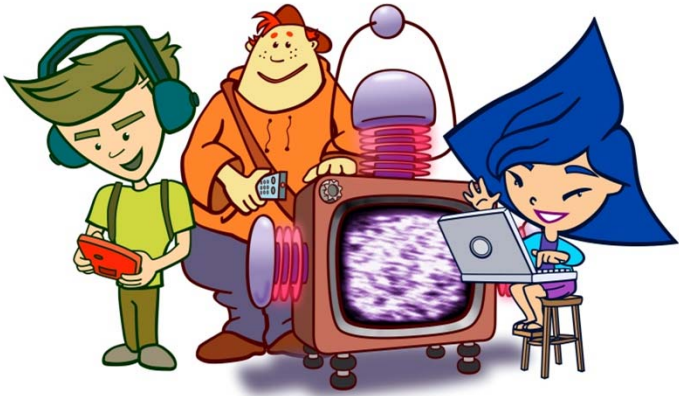
Participant questionnaire (ages 9-11)

Education Programs

Post-program teacher surveys (grades 2-8)

Post-program student surveys (grades 2-7)





# Assessment - Engagement

Can particle physics be engaging to elementary and middle school aged youth?

**YES!**

- Over 90% of students rated the program 3 or higher out of 5; more than 50% gave the highest rating
- What would you tell your friends?

*I had fun and they should have been there (5<sup>th</sup> grader)*





# Assessment - Understanding

Can young children grasp the concept of something they can't directly see?

**YES!**

- Interviews & questionnaires show children as young as 7 can grasp the idea of small things they cannot directly see, and that special equipment is needed
- Program surveys show links with concepts explored:

*Quarks are very, very tiny (3<sup>rd</sup> grade)*

*I discovered that there is no possible way to make a giant bug that will take over the universe.” (6<sup>th</sup> grade)*

*I learned that everything is made of matter and quarks are made of nothing else (7<sup>th</sup> grade)*

# Assessment - Relevance

Do TEACHERS feel the ideas explored are relevant to their students and what they are currently doing?

**YES!**



- 100% of teachers felt the programs were valuable from both a curriculum and affective perspective
- ALL said that the programs provided a positive and fun science experience for their students
- Teacher comments:

*Was wonderful; tied together some things I've already taught. Introduced new ideas and furthered knowledge." (2<sup>nd</sup> grade)*

*I think the kids were actively involved and also intrigued by new knowledge. They were also able to draw up on [lesson learned] just this year (4<sup>th</sup> grade)*



# Status & Future Plans

## Education Programs & Overall Project

- Education programs continue to be available
- Over 5,000 youth reached by programs (Kansas, Missouri, Colorado)
- Publications in teacher and education journals about overall program and assessment pilot study

## Web Resources

- Continues to have over 5,000 visitors/month
- Animated videos shown on public television
- New content added or under development
  - Photon Invaders game exploring solar panels
  - New animation about electricity and superconductors
  - nano & energy additions to glossary, FAQ, resource links, games, etc.





## KIDS CAN HAVE FUN & LEARN ABOUT PARTICLE PHYSICS !

### PUBLICATIONS

- \* T. MacDonald and A. Bean, *Adventures in the Subatomic Universe: An exploratory study of a scientist-museum physics education project*, **Public Understanding of Science**, 1-17 (2010).
- \* Teresa MacDonald and Alice Bean, *Get Quarked!*, **Science Scope** vol 33,4, pp43-47, (2009).
- \* Teresa MacDonald and Alice Bean, *Quarked! – Adventures in Particle Physics Education*, **The Physics Teacher**, Vol 47, Issue 1, (2009).

