Quake Catcher Network (QCN) – Earthquake County Alliance (ECA) Earthquake Education and Public Information Center (EPIcenter) Seismic Network

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I. Summary

Proposed and outlined in this document is a plan for the development of the QCN-ECA EPIcenter Network. As a "network within a network," the QCN-EPIcenter Network will assist participating free-choice learning institutions in the engagement of diverse audiences in QCN-sensor activities through the provision of program materials and products. The QCN-EPIcenter Network will support the respective missions of QCN, the ECA EPIcenter Network, Members of the ECA EPIcenter Network, and collaborating earthquake-related institutions (e.g., USGS[1], SCEC[2], NEES[3], IRIS[4], NSF[5], CGS[6], EarthScope, and UNAVCO[7]) by providing access to cutting edge technologies and research in earthquake science and preparedness. Overall, the QCN-EPIcenter Network hopes to increase knowledge of earthquake science, earthquake preparedness, and research in communities and regions throughout California.

II. Background

The Quake Catcher Network (QCN)

Managed by Stanford University and the United States Geological Survey Pasadena Field Office, the Quake Catcher Network (QCN) seeks to form the world's largest strong-motion seismic network by empowering individuals with software to improve earthquake monitoring, earthquake awareness, and the science of earthquakes.

For several years QCN has administered an innovative and collaborative initiative for developing the world's largest, low-cost strong-motion seismic network by utilizing motion sensors in and attached to internet-connected computers. QCN links volunteer hosted computers into a real-time motion-sensing network. The volunteer computers monitor vibrational sensors called micro electro-mechanical systems (MEMS) accelerometers, and

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[1] U.S. Geological Survey
[2] Southern California Earthquake Center
[3] Network for Earthquake Engineering Simulation
[4] Incorporated Research Institutions for Seismology
[5] National Science Foundation
[6] California Geological Survey
[7] University NAVSTAR Consortium

digitally transmit “triggers” to QCN’s servers whenever strong motions are observed. QCN’s servers sift through these signals, and determine which ones represent earthquakes, and which ones represent cultural noise (e.g., doors slamming or trucks driving by). QCN is one of many scientific computing projects that run on the world-renowned distributed computing platform, Berkeley Open Infrastructure for Network Computing (BOINC), developed by collaborators at the University of California, Berkeley. With the help of these citizen volunteered computers, QCN has provided a better understanding of earthquakes, as well as helped to advance earthquake warning and response systems.

QCN has also developed educational software, QCNLive for learning using the sensors and lesson plans to teach about earthquake vibrations and where earthquakes occur. QCNLive has two modes: earthquake viewing and sensor viewing. Sensor viewing demonstrates sensor functions, while earthquake viewing allows students to search the globe for the most recent earthquakes.

QCN has been so successful that it has inspired and provided the basis for the development of other similar programs, such as the Community Seismic Network recently created by the California Institute of Technology.

The Earthquake Country Alliance (ECA) Earthquake Education and Public Information Center (EPIcenter) Network

Members of the ECA EPIcenter Network share a commitment to encouraging earthquake and tsunami preparedness by demonstrating leadership in risk-reduction and education. Members may coordinate ECA activities (e.g., the Great California ShakeOut), lead preparedness presentations, organize educational activities, or in other ways demonstrate leadership in their communities, counties, or regions. Overall, Members of the EPIcenter Network serve as environments that provide multiple contexts where people can understand and learn how earthquakes can affect the local, national, and global community.

The EPIcenter Network began as an informal alliance in 2008. A product of the combined efforts of SCEC and the San Bernardino County Museum, the EPIcenter Network initially formed to broaden participation in the 2008 Great Southern California ShakeOut. In 2009, alongside the expansion of the ShakeOut into a statewide effort, the EPIcenter Network grew more comprehensive in scope. Currently, Members of the EPIcenter Network represent over 60 free-choice learning institutions (e.g., parks and outdoor areas, natural history museums, science and technology centers, colleges and universities, children’s museums, libraries, and other types of free-choice learning institutions) throughout California. The EPIcenter Network continues to interpret and disseminate scientifically accurate information to the general public, and it is managed by the Southern California Earthquake Center (SCEC).

Free-Choice Learning Institutions

Environments for free-choice learning include family discussions at home, everyday activities (e.g., gardening), after-school programs (e.g., summer camps), and designed spaces (e.g., museums, national parks, and science centers) (Bell, et al., 2009; California Association of Museums [CAM] & American Association of Museums [AAM], 2010; Falk et al., 2007). In contrast to formal learning, free-choice learning is lifelong, intrinsically motivated, voluntary, open-ended, context specific, and dependent on life connections of an individual (e.g., prior knowledge, interest, background, and values) (Anderson, Piscitelli, &

Weier, 2002; Anderson, Lucas, & Ginns, 2003; Anderson, Storksdieck, & Spock, 2007; Bell, et al., 2009; Falk & Storksdieck, 2005; Falk et al., 2007). Over the past 50 years, increased research on free-choice science learning has revealed the vital role of free-choice learning institutions in the science education and knowledge of the public. In essence, through developing interest in science, facilitating the learning of science practices, and increasing reflections on science, free-choice learning institutions affect individuals' understanding of science and science-related issues in everyday life and on a national scale (Bell, et. al., 2009; Falk, Storksdieck, & Dierking, 2007).

The QCN-ECA EPIcenter Seismic Network

QCN has experienced numerous successes in engaging schools in their sensor program. However, the majority of all lifelong science learning is suggested to occur outside of school through free-choice learning (Bell, et. al., 2009; Falk, et. al., 2007). The proposed QCN- EPIcenter Network directly engages the free-choice learning institutions of the EPIcenter Network as new participants for the QCN program. By leveraging the resources of EPIcenter members, QCN will be able to expand and reach audiences not currently served by schools. In other words, EPIcenters will serve as platforms on which long-term partnerships may be forged and sustained. QCN implementation in EPIcenters will also enhance visibility of the program among formal learning institutions due to schools' frequent utilization of free-choice learning institutions for field trips and other educational experiences.

III. <u>Program Implementation</u>

One possible mode of distribution of QCN sensors to free-choice learning institutions is via a lending program. The institutions will first be presented with an initial explanation of the QCN-EPIcenter Network and its products. Ideally this explanation would be on a website, but can also be presented to them in other ways (e.g. a PDF brochure or live presentation). This introduction will briefly explain the sensors and their use, specifically highlighting the existence of and difference between the two software—BOINC and QCNLive. If the institutions would like to participate in the program, they would then submit an application to the program.

<u>Application (By first creating a profile on the QCN website)</u>:
-Basic institutional info (Name, Address, Contact info, etc).
-Choice of software (BOINC, QCNLive, or both)
-Contract
- Outlines a 6-month lending period.
- Binds them to help the network gather information about their use of the sensors. This post-sensor participation will include documentation of their use of the sensors and completion of a survey.

After an application is submitted, a Kit will be created for each institution. The Kits should be returned along with completed documentation and survey materials after the 6-month lending period.

We propose a 6-month lending period for the QCN-EPIcenter Kit, with the option for institutions to keep the Kit longer provided that certain evaluation milestones are met. The primary justification for a lending program instead of free distribution of the sensors is that materials given away free of charge are often devalued. Placing a timeline on implementation will encourage institutions to value the program and the product. Without any deadline, institutions may put off implementation of a program. In contrast, a deadline to return the sensors will prompt them to make efficient and effective use of the lending period. Additionally, a lending program is appropriate based on the assumption that at first, museums may only implement a temporary program to see if the Kit is a good fit for their institution. If the sensors are given away permanently, the museums may not have a long-term use for them, which would result in a waste of our supply.

IV. Evaluation

It is crucial for the QCN-EPIcenter network to measure the success of the Kit for better improvement of the program. There are many points to investigate when evaluating success. There is quantitative data to find—how many Kits are distributed, how many institutions are involved, how many types of institutions are involved, etc. There is also important qualitative data to be gathered—what are the outcomes of this product, what are the long-term effects and implications of the Kit? Such feedback and data will be gathered through the following methods of communication:

Documentation of Use

As outlined in their initial application contract, participating institutions will be required to submit documentation of their use of the Kit upon returning it. Although we can consider having a standardized documentation method, it may be best to leave the method of documentation up to the individual institutions. Aside from providing basic requirements (e.g. photos), it may be most effective to let the institutions choose what works best for them within their institutional context.

Survey

The institutions will also be required to submit a completed survey when they return the Kit to us. The survey will require the institutions to answer questions and rate elements of the Kit based on usefulness, relevancy to their purposes, and other criteria. There will also be a space for then to make comments and suggestions.

Post-Participation Communication

In addition to the documentation and survey, it will also be helpful to gather information about the experiences of participating institutions' use of the Kit through conversations and interviews. The conversations will be conducted through meetings, site-visits, or via telephone with QCN-EPIcenter Network staff. Through further dialogue, there will be an increase in opportunities for institutions to provide feedback and reactions to the Kit.

The responses and data collected will be analyzed through the use of Logic Models. A method of outcomes-based evaluation approaches the Logic Models will serve as graphical representations of the Kit and show the relationships between the Kit's design, implementation, and impact (Applegate, 2007; Cutler, 2009; Dudden, 2007; Storksdieck, 2005; Taylor-Powell, E., & Henert, E., 2008). Through the gathering and analysis of responses, the QCN-EPIcenter Network staff will then be able to modify the Kit to better serve each institution.

V. Marketing and Promotion

Communication

Good communication with the participating institutions will be key to the Kit's success. Once the institutions have received the Kit, we should continue to follow up with them via telephone or a monthly e-mail. This would serve as a reminder that we are available to assist them with any questions and issues they may have. This continual contact will encourage use of the sensors within the lending period.

Advertising the QCN-EPIcenter Network

The Kit would also be a great venue through which to advertise the QCN-EPIcenter network. QCN and EPIcenter promotional materials, such as brochures, should be included within the Kit. If available, a printed newsletter could also be included. Newsletters would help to build up the sense of community, as well as raise awareness about upcoming events, like the Shakeout. In the future, instructions on how to add the QCN and EPIcenter logos onto institutions' homepages could also be included.

Online Presence

Once the program is established, the Kit must be advertised in order to promote interest and use. The most effective way of doing this will be oral communication—we will need to talk to individual institutions to raise awareness about our product. However, this must be supplemented by an online explanation and advertisement of the Kit. As such, there is a strong need for an online home for the QCN Kit.

An Online Home for QCN would allow us to:

-Introduce & advertise the product
-Post the Kit Application & Contract
-Post the Post-Participation Survey
-Provide a venue for institutions to share Documentation of their Use
-Provide a venue for troubleshooting

VI. QCN-ECA EPIcenter Kit

Goals

The QCN-ECA EPIcenter Kit aims to:

1) ensure that we are helping the institutions meet their goals,
2) appeal and encourage partners (e.g. NEES, IRIS, CGS, USGS) to help promote QCN by incorporating their ideas,
3) serve as a medium to promote the QCN and EPIcenter networks, and
4) foster education in earthquake science while also promoting research in the field.

Kit Varieties and Contents
Kits will come in three types: the QCNLive version, the BOINC version, and the full suite. The QCNLive version is geared toward use for demonstrations involving the QCN sensor. The BOINC version is geared toward a continuous watch for earthquakes.

For all Kits

- QCN USB Sensor Installation Guide for Windows and Mac: provides step-by-step installation instructions; sensor, BOINC, QCN drivers, and QCNLive installations
- Development Opportunities – How to Participate and Software/Hardware Interfaces: list of interfaces capable of supporting QCN; technical details
- 1 or 2 QCN sensors (depending on choice of Kit)
- QCN and EPIcenter brochures: provides a way to introduce and advertise the networks.
- The ShakeOut Earthquake Scenario booklet: Involves USGS and CGS while also making an overt connection with ShakeOut. In addition, the booklet gives a sense of the timescale and expectations involved in an earthquake and allow comparison with QCN detection and response time.
- ShakeOut Flyer
- Putting Down Roots in Earthquake Country booklet: Emphasizes on earthquake preparedness, which complements the purposes of the ShakeOut program
- The QCN Handbook: Gives an introduction to the QCN-ECA EPIcenter Network. Shares publications of QCN sensor usage in earthquake research. Briefly describes various educational activities that may be performed in conjunction with QCN sensors. Answers frequently asked questions and provides links to additional resources. Gives information regarding web presence.

For QCNLive Kit and full suite

- QCNLive User Manual: QCNLive features and manual; explains Earthquake Viewing Mode and Sensor Viewing Mode capabilities
- School Seismic Safety Seminar or Earthquake Publications for Teachers and Kids CD
- Slinky
  - Great for illustrating difference between P-waves and S-waves. May be used in conjunction with certain demonstrations.
- Simple Experiments (included in the QCN Handbook)
  - Soil Liquefaction by NEES
    - Illustrates the concepts of liquefaction, compaction, and earthquake engineering
    - http://nees.org/resources/2942
  - Quake Catcher Network Lab by NEES

        - An activity that guides users through the QCN interface, and gives a brief explanation of acceleration
        - http://nees.org/resources/2825/
    - Make Your Own Earthquake by NEES
        - With QCNLive, under the 'File' tab, you can 'Make an Earthquake'. This has a countdown that you can change to variable times, and then make an earthquake, by banging the desk or stomping their feet, etc. Then, the generated earthquake prints to a pdf file that you can print (or email a pdf).
        - http://nees.org/resources/2818/ (K-4)
        - http://nees.org/resources/2819/ (5-8)
        - http://nees.org/resources/2820/ (9-12)
    - Slinky Demonstration by the Exploratorium
        - Using the slinky, reproduce P-waves (compression), S-waves (shear), Love waves (SH waves usually parallel to earth's surface), and Raleigh waves (rolling waves)
        - http://www.exploratorium.edu/faultline/activezone/slinky.html
    - Magnitude and Intensity Lab by IRIS
        - Utilizes QCN sensor capabilities to demonstrate difference between magnitude and intensity.
        - Perhaps an answer key to some of the questions that have a clear answer to them
        - Attenuation
            - Introduce with QCNLive how dropping a weight from different distances will generate different amplitude seismic waves, and how different size weights (i.e. bigger earthquakes) will generate different amplitude seismic waves.
        - http://www.iris.edu/hq/files/programs/education_and_outreach/lessons_and_resources/docs/mag_inten/ and download Mag_Inten.doc
    - What is a Seismometer by QCN
        - An activity that allows students to explore how a seismometer works using QCN. Demonstrates how QCN uses the three coordinate axes to measure earthquakes.
        - http://qcn.stanford.edu/learning/Activity1-QCN.pdf (K - 8)
        - http://qcn.stanford.edu/learning/Activity1-QCN-HS.pdf (6 - 12)
- Other experiments (included in the QCN Handbook)
    - Shake Things Up! by NEES
        - Construct a simple shake table
        - http://nees.org/resources/3923
    - Earthquake Machine by USGS

  - Illustrates fault slips and the concept of earthquake unpredictability
  - QCN sensor can be mounted on brick
  - http://earthquake.usgs.gov/research/modeling/earthquakemachine.php
- Earthquakes and Buildings Lab by QCN
  - A design challenge aimed toward students to demonstrate the effects of earthquakes on building integrity. Requires students to build with a limited pool of resources and subsequently quantifies the structure's strength with QCN sensors.
  - http://ldt.stanford.edu/~educ39109/POMI/DBL/
- Modified Boss (BOSS Lite) Model by IRIS
  - A simple version of the BOSS model that demonstrates the effects of earthquake frequencies with natural building frequencies.
  - QCN sensor may be able to attach to the "foundation" of the model and record the frequencies of the shaking.
  - http://www.iris.edu/hq/resource/boss_lite_building_resonance
- Boise State Vertical Slinky Seismometer
  - A relatively large but inexpensive seismometer that uses a slinky, magnet, and coil
  - Requires time and self-assemblage
  - http://earth.boisestate.edu/pal/files/2011/12/slinky_poster.pdf

For BOINC Kit and full suite

- Printed newsletter: informs of upcoming events and provides a sense of networking within EPIcenter.

Appendix A: Irene Gow's Logic Model Research Abstract

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The Impact of the Earthquake Country Alliance (ECA) Earthquake Education and Public Information Center (EPIcenter) Network
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Ranging from designed spaces to everyday activities, informal learning environments account for the majority of the public's science knowledge and education. Despite an increase in research of informal science learning over the past 50 years, there remains a need for comprehensive outcome measures. Established evaluation methods would improve overall science learning and the management and accountability of informal learning institutions. This study was conducted to address the current lack of methodology through the

development of impact measures for the Earthquake Country Alliance (ECA) Earthquake Education Public Information Center (EPIcenter) Network.

Formed in 2008, the ECA EPIcenter Network currently consists of over 60 informal learning institutions throughout California. Members of the Network are committed to encouraging earthquake and tsunami preparedness through demonstrated leadership in risk-reduction and education. Grounded Theory, a qualitative methodology, was used to develop evaluation methods for the Network through simultaneous data collection and analysis. Open-ended interviews were conducted with six Members of the Network's Southern California Region, a convenience sample representing five types of informal learning institutions (e.g., museums, children's museums, libraries, science centers, and outdoor areas). Data from the interviews were incorporated into logic models, graphical representations of program outcomes.

The logic models for the six informal learning institutions and overall Network revealed similar theoretical long-term outcomes: strengthened community partnerships, the incorporation of earthquake science into different contexts, increased awareness of earthquakes, and increased community earthquake education, earthquake preparedness, and knowledge of earthquake science. Continued refinement of the use of logic models to measure the impact of the Network and informal learning institutions is needed through the collection of quantitative data. The development of comprehensive impact measures will not only affect the sustainability of the ECA EPIcenter Network and other informal learning institutions, but also affect statewide, national, and international approaches to earthquake education and emergency preparedness.

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