



The Janus Called Citizen Scientist a Closer Look

Timir Datta*

Physics and Astronomy, University of South Carolina, Columbia, SC 29208, USA

The phrase citizen scientist is drawing intense publicity these days. It is cool to be involved in this and all over the world various groups cater to a wide range of interests. For instance, a Google search yielded 'about 6,380, 000 results' in a few seconds. The buzz of science cover stories, opinion-pieces, blogs and news items has recently risen [1] into the stratospheric heights of the 1600 Pennsylvania Avenue, Washington, DC, USA. A motivation for the present piece is to examine this popular and complex trend.

Throughout history lay citizens have contributed to science. For instance, in the *Principia Mathematica* to compute the mass of the moon [2]. Sir Isaac Newton used tidal records from maritime logs. On other occasions such contributions, especially those made by gifted enthusiasts have made significant additions to the body of science. A prime example amongst the genius amateurs is the 19th century 'fossil hunter' Mary Anning, the story of her humble background and prodigious contributions to paleontology are legends. In 2010, the Royal Society belatedly recognized Anning as one of the ten most influential British women in science.

Interestingly, ever since the Hellenic times pure science has had no masters and occupied the reserved position on top of the pedestal marked 'knowledge for the sake of knowledge' [3]. In contrast, because it may never violate any laws of science plus neither shall it transgress the laws of the society that creates it, technology serves many a master. Also technology has always been at the whims of the society's movers and shakers.

Consequently there is a potential for tension in mixing science with people and policy. Many authors don't differentiate much between the two nouns science and scientist and use Citizen Science and Citizen Scientist interchangeably! However there is a long established tradition of making a clear distinction between the terms and they really mean two very different things. Also, do citizens have a right to volunteer or boycott any science, should citizens have a say in what questions a scientist may ask [4], are all knowable need to be known to science and should some knowledge be anathema? In addition what are the boundaries of citizen activity and to what extent citizens be held culpable? Hopefully, the present piece would motivate the readers of this journal to help answering these questions.

In 2015 the contributions of John Q. Public may even be more important than ever before. As a matter of fact it seems that almost every day video's of many rare ephemera or previously unseen occurrences that get recorded and go viral on the Internet moments later – instant citizen science!

The label citizen applies across national boundaries and many social media platforms are direct gateways to this global population. Digital media provides the additional benefit of prescreening, the 'connected' who also happens to be better educated, as well as the top percenters in their respective societies. A prime example of leveraging success in science via social media comes from Lee Berger a paleoanthropologist at the University of Witwatersrand, in South Africa who is better known as Mr. Paleodemocracy'. Berger's implorations in Facebook, Twitter and LinkedIn generated unprecedented enthusiasm and productivity from 'youthful' collaborators, leading to the recent discovery [5] of

Homo naledi, a totally new species of humans!

All of this could not have happened in vacuum, I mean both in the literal and figurative senses of 'vacuum'. Remember the days of vacuum tube technology, that gave us radio communication, TV and computers all right, but these things were like full-size furniture, energy guzzling behemoths that run as hot as toasters?

Yours truly remembers his youthful days in the 1970's, at NASA's Jet Propulsion Lab in Pasadena, California, when he would carry boxes full of punched Hollerith cards to the 'Deep Space Computing Center' for 'batch processing' - cards submitted first thing in the morning were to be returned at the end of the day along with a sheet or two of 'line printed output'.

Remarkably, despite its impressive panels of flickering miniature lamps, bleeping machine sounds and reel-to-reel tape banks that were manned by pocket protected, white liveried personnel, the center's rate of computation plus ability to store and access data, was far inferior to what is achievable today by a single chip, that too the size of a finger nail that runs for days on a 'AAA' battery!

Still just hi-powered integrated chips are not enough, a world with just a few smart phones joined by wires won't do it, these may serve a couple of presidents and heads of states with peons totting around 'hot-line phones' - but not the advent of citizen scientists! For citizen participation waves bouncing off the ionosphere or satellites is not the way to go, as history shows the way forward was wireless only within a local cell and no 'energy absorbing electric signals' but light signals carried globally by fiber optics.

Low energy and mobile made technology attractive, integration reduced cost, competition and economy of scale affordable entry cost snow balled into still lower cost so-much-so that mobile smart phones became billion plus unit selling commodity products that they are today. But the story of digital technology and economics of citizen electronics is better left to be told on some other day.

In a piece in 'This Week' section of the 20 August 2015 issue of Nature [6]. Rise of the citizen scientist it was asserted that "Technology can make scientists of us all...". By this logic the billions of us selfie takers have been transformed into if not Ansel Adams, then Richard Avedon or Annie Leibovitz, correct? Resoundingly not! Then Nature's phrase "twenty-first-century treasure hunters" brings to mind the second question who's 'treasure'? Is it treasure for the individual collector, the 'King and the country', 'mankind' or the good old 'Mother earth's'.

*Corresponding author: Timir Datta, Physics and Astronomy, University of South Carolina, Columbia, SC 29208, USA, Tel: 803-777-2075; E-mail: datta@physics.sc.edu

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The importance of our planet is also central in California Academy definition “non-scientists aid researchers in solving questions about Earth...”

Curiously it is not only that science has this opportunity of utilizing hitherto untapped but also immense mobile wielding citizen power but perhaps the citizen has already had enough fantasy football for the moment and appears to be looking for something new; put it another way, all the cool stuff at hand but little to do. In one of the Whitehouse events mentioned earlier Dr. John Holdren, the director of the White House Office of Science and Technology Policy, has reportedly send out directives requiring

(i) every agency to designate a coordinator for citizen science and crowdsourcing projects and

(ii) (ii) agency to catalog the its citizen-science and crowdsourcing activities that are open for public participation. Also a ‘new crowdsourcing toolkit for government agencies’ has been developed.

The National Science Foundation (NSF) has been supporting such activities since the early 2000’s. But a Sep 28, 2015 posting reports that the NSF has just awarded a \$300,000 Pathways grant to Arizona State University’s Center for Engagement and Training in Science and Society for the development of SciStarter 2.0. The grant will advance the growing field of citizen and community science, which enables everyday people to contribute to authentic research.

SciStarter 2.0 Creates an Identity Management System for Citizen Scientists it aggregates more than 1000 citizen science projects on a single website, is a research affiliate of Arizona State University. SciStarter 2.0 will go beyond the current ability to include:

- Identity management system with open integrated registration for participants to more easily engage in multiple citizen science projects, even across platforms and disciplines
- would-be participants can find opportunities near them
- easy tracking of their projects, participation, and contributions to science
- privacy-protected profiles and find people and projects of interest to them

Social media, shared economy, Bitcoin, Uber Airbnb and smart phone Apps are attempts to commercialize this underused technology in the consumer’s disposal. Add to this witches’ brew of the immense digital capabilities with intense collective desire of the *cognizanti* who are twitching for action the open invitations for agency funding- Boy! Who ordered this cocktail?

The big tent of citizen science, covers a large number of activities ranging from improving computer software to highway traffic flow but a select few broad topics such as astronomy, climate, environment, earth sciences, medicine, nature and wildlife appear to be most active. Here is a quick list some web addresses with a few descriptive statements for the reader to glance thru.

(i) “Help develop the world’s largest, low-cost strong-motion seismic network”

(ii) <http://www.scientificamerican.com/citizen-science/The>

Quake-Catcher Network

(iii) “share and contribute to data monitoring and collection programs. Usually this participation is done as an unpaid volunteer...” <http://education.nationalgeographic.com/encyclopedia/citizen-science/> The Valley of the Khans “For more than 100 years, National Geographic explorers have unraveled the mysteries of the past. Now it’s your turn”

“Answer serious scientific questions, provide vital data to the astronomical community, and have discovered thousands of objects including nebulas, supernovas and gamma ray bursts... look at animated images from NASA’s WISE space telescope and other telescopes, and help astronomers hunt for good disk candidates among galaxies, asteroids and interstellar dust.... you will collect data on cloud type, height, cover and related conditions. Your observations help us to validate satellite data and give us a more complete picture of clouds in the atmosphere and their interactions with other parts of the integrated global Earth system... Stardust@Home “Help find the first pristine interstellar dust particles ever brought to Earth”. Citizen Sky “Help scientists solve the mystery of epsilon Aurigae, a mysterious, bright, eclipsing binary variable star that has baffled scientists since 1821 <http://science.nasa.gov/citizen-scientists/> Lunar Impact Monitoring

Not surprisingly the Smithsonian has a big effort, its URL is <https://qrius.si.edu/get-involved/citizen-science>

(iv) Calling all birders! eBird is one of several Cornell Lab citizen-science projects aimed at better understanding our feathered friends as well as other wildlife ...A blog inspired by the contributions and passions of citizen scientists...”<http://www.birds.cornell.edu/citsci/>

(v) The question, what is a “Citizen Naturalist” is asked and answered at the NWF website as “Citizen Naturalists are people concerned about the environment who choose to help make a difference both locally and nationally. They spend time outside, observing nature with a critical lens. ... “<http://www.nwf.org/Wildlife/Wildlife-Conservation/Citizen-Science.aspx>

(vi) Here is one for computer programs: DARPA Verigames Crowdsourced Formal Verification (CSFV) project help software developers detect flaws that make their programs vulnerable to hackers. It needs to be pointed out that there are several sides to this movement – by all matrices Citizen Science is a fledging genie, it is emerging but a lot is unknown. Because similar to thermodynamic systems, any organization with large degrees of freedom has invariants, symmetry breaking and emergent behaviors [7]. –a crowd of well-behaved individuals may become unpredictably rowdy at a soccer or rock event. For example, the cover story of the September 14, 2015 issue of the Chemical & Engineering News (C&EN) lauded [8] how regulatory agencies are taking advantage of water quality data collected by volunteers, but then the following article [9] details pushback from state governments. It is not at all unexpected that there is push back by parties that are often the targets of the citizen science activities, which includes government, establishment, vested interest groups and private entities. The nature article states, “full transparency about the motives and ambitions of amateurs is essential”. Above all this burgeoning and exciting movement is bound to evolve and hopefully over time it will constitute a new form of collective activity with a lasting and positive contribution to society [5-9].

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