Getting to Citizen Science

An investigation of the landscape, typologies, and design frameworks of public participation in scientific research

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Why Citizen Science?

Public participation in scientific research, commonly called citizen science, has the potential to gather much-needed scientific data at large spatial and temporal scale[1], advance scientific literacy in participants[2], engage dialog between scientists and stakeholders, and grow capacity for science-informed management and policy[3]. Encouraged by these potentials and more, public participation in scientific research (PPSR) is on the rise.

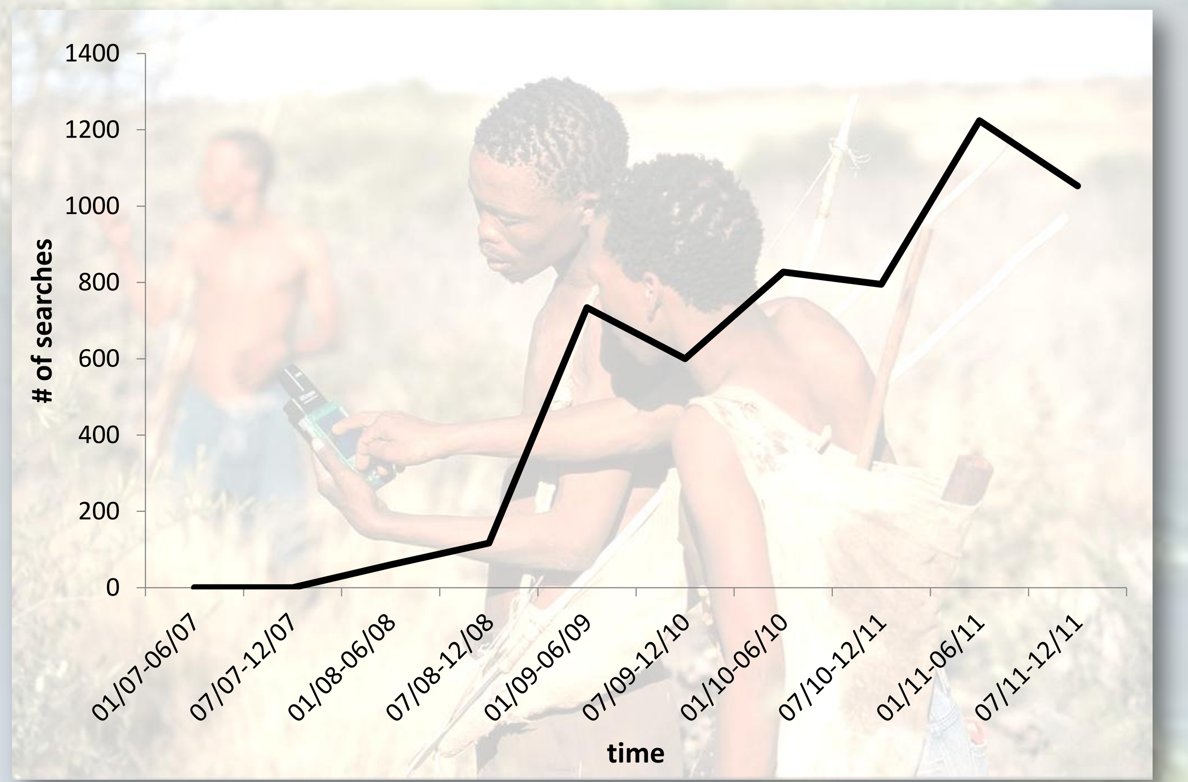

Fig 1. Trend in Google searches for the term "citizen science" over time.

Yet, nomenclature, best practices, typologies, and those program design features predictive of success in PPSR are still emerging and often disagree. As such, researchers say, "it is difficult to cumulate findings or to determine how or if one project's experiences will be relevant to another."[4] Moreover,

Many projects fail to capitalize on the opportunities presented by public participation[5,6]

In looking to build robust PPSR programs, I worked to find clarity in this burgeoning field. I asked simple, but necessary questions:

1) What is the landscape of PPSR?
2) What, specifically, is "citizen science"?
3) How do published typologies parse out the PPSR landscape?
4) Do the typologies capture the PPSR landscape?
5) What elements and practices are requisite to successful PPSR program design and operation?


Citizen science training, AVEO 2011

Methods

Questions 1 & 2: To become knowledgeable of the PPSR landscape and to ascertain what, specifically, citizen science is, I analyzed twenty-six randomly selected PPSR projects. I also immersed myself as a public participant in four projects. The thirty projects were analyzed across seven key project parameters for commonalities and differences. The parameters were: project goals, degree of public participation, study focus, method of data collection, spatial/temporal scale and scope, project self-description, and organizational factors. Based on these parameters, I classified projects to type based on published PPSR typologies.

Questions 3 & 4: Through a literature review, I identified five typologies/sets of models meant to describe and delineate various kinds of PPSR. The typologies were analyzed for commonalities and differences, and used to classify each of the thirty case studies. If typologies/models missed key features of projects, I understood this to be a deficiency of the typology in capturing the landscape of PPSR.

Question 5: Through a literature review, I identified five program design and operation frameworks meant to guide practitioners in building projects to engage the public in scientific research and conservation. These frameworks were analyzed for commonalities, differences, strengths, and weaknesses, and subsequently aggregated into a comprehensive framework for the design and operation of PPSR projects.

Findings

The landscape of public participation in scientific research is rich. Projects vary widely across each of the seven parameters studied (Table 1). Despite this richness, particular parameters, combinations of parameters, and types of PPSR dominate the landscape. For example, 80% of projects studied were classified as the citizen science type of PPSR when compared against typologies (Fig 2). Furthermore, 82% of projects studied focused toward conservation and/or ecology. In pairing project type and study focus, I found that 71% of PPSR projects were in the citizen science model and focused on conservation and/or ecology (Fig 3).

While there is wide variety in the PPSR landscape, 71% of PPSR projects studied were in the citizen science model and focused on conservation and/or ecology

Table 1. A Cross Section of Case Study Project Parameters and Descriptions

Project	Stated Goals	Participation	Focus	Method	Scale/Scope	Self-described	Organizational Features
Calico Early Man Archeological Dig	provide opportunity for pub participation in research, promote scientific discovery	dig for, collect, and analyze findings, help manage site	archeology, anthropology, paleontology	field-based	local, ongoing	public participation in archeology	community group-lead, participation-driven, project formed by Friends of Calico
Tu Analyze	advance diabetes research, empower community, improve pub health response	contribute health data	public health	computer, smart phone app	international, ongoing	n/a	non-profit/community collaboration
Great Swamp Stream Team	monitor the watershed, advocate, educate	total participation where possible	public health, conservation, ecology	field-based	local, ongoing	volunteer monitors	member supported non-profit-lead, science to action-driven
Salish Sea Hydrophone Network	monitor for orca sounds, measure ambient noise	remote sensing	conservation, ecology	home-based listening to live feeds	international particip. for local effort, ongoing	n/a	non-profit-lead, science-driven, no education
C3: Communicating Climate Change	determine temp differences between urban and rural	data collection	climate	field-based, smart phone app	state-wide, ongoing	citizen science	Maryland Science Center and university-lead, science-driven
Great Worldwide Star Count	encourage astronomy education	contribute observations	astronomy	home/field-based, computer submission	international, 1 specific week	citizen science	teacher's association-lead, education-driven, no driving research question
Global Garlic Mustard Field Survey	gather data on abundance and distribution of mustard	data collection	conservation, ecology	field-based, computer submission	international, ongoing	citizen science	cross university-lead, science-driven

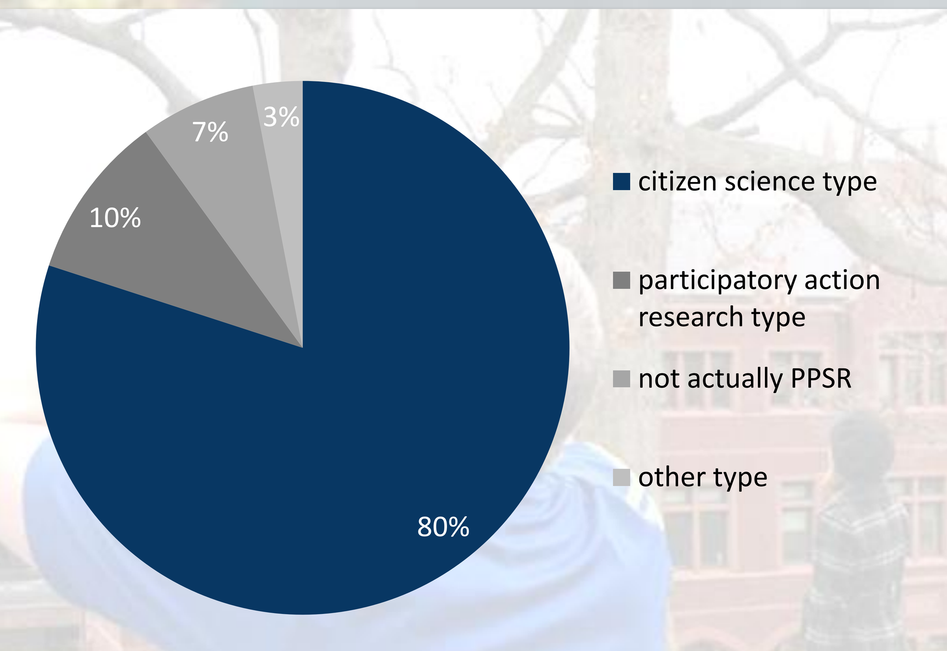

Fig. 2- Percentage of case studies classified to particular PPSR types. Most case studies (80%) were classified in the citizen science type.

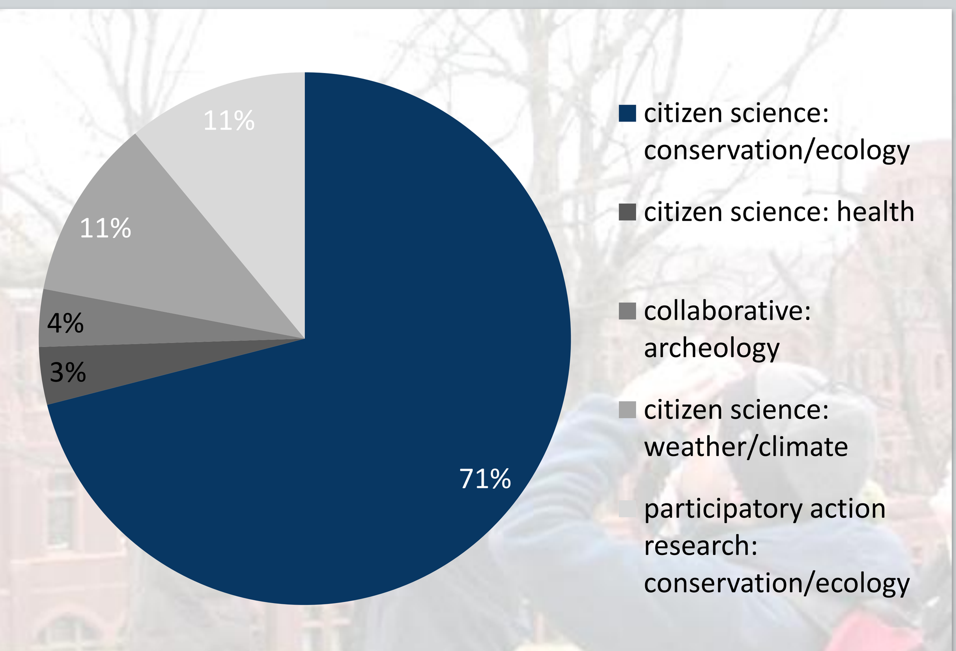

Fig. 3- Pairings of type and study focus show 71% of PPSR case studies were conservation/ecology focused in the citizen science type.

The typologies examined were congruent at extreme ends of participation. For example, where public involvement was limited to data collection, typologies agreed this was a specific type typically called citizen science. Where the public is involved throughout the scientific process, the typologies agreed this was also a specific type, typically called participatory action research.

Of the 80% of projects classified as citizen science when typed, 63% self-identified as such. These findings suggest that in academia and in the field of practice, "citizen science" is generally understood as public participation in a scientific research where the role of the public is to contribute data.

However, because researchers and the public use "citizen science" to describe the overall phenomenon of public participation in scientific research, nomenclature remains unsettled.

Citizen science is not only descriptive of one type of PPSR, it is also descriptive of the overall phenomena of PPSR. Agreed upon nomenclature is scarce, and problematic.

Suggested typologies based on level of public participation did little to enlighten the fundamental differences between PPSR projects. Level of participation was not *necessarily* linked to other project parameters *nor to project outcomes*. Typologies based on project goals and organizational features captured more fundamental differences, but told nothing of level of participation– a meaningful parameter. Cross-pollinating typologies produced a more accurate description of the key differences in projects and of the variety in the PPSR landscape.

Typologies based on level of public participation do not capture fundamental features of projects.

Across the five design frameworks studied, there were 43 principles of design, of which 21% were common to all. Principles in common were overwhelmingly those standard to scientific research. Major differences were found in those design elements specific to public participation. No single framework was complete in providing clear mechanisms for realizing the full potential of PPSR.

No single project design framework is complete in providing clear mechanisms to realize the full potential of PPSR. Aggregating frameworks is useful toward building programs to achieve goals by design.

Discussion

If we are to capitalize on and leverage the potential of PPSR, if we are to be successful in achieving goals *by design*, it is essential that we understand the variability in this system, that we recognize what distinguishes one PPSR activity from another, and that we know what program design elements are requisite to project success. This analysis of the PPSR landscape and suggested typologies has revealed where there is solid ground upon which we may begin to accrue findings, and where field remains unsettled. Analysis of project design frameworks has revealed the essential elements of PPSR and, in aggregating frameworks, I have produced a rough version of the kind of comprehensive tool that will be necessary in building PPSR programs moving forward.

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