

# the Cave Pearl Project

## Building an online platform for Broader Impacts & educational outreach

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### A natural experiment...

Web-based platforms are often used for informal science education (ISE) as part of broader impacts (BI) strategies, despite uncertainty about how effective these resources are at broadening the societal awareness of publicly funded research. There is a need to improve science education, and identify the best way to attract visitors.

We present insights from The CavePearlProject.org (CPP.org), a media rich blog initiated in 2014, which documents the development and use of a data logging platform for research in coastal aquifers.

Content categories include:

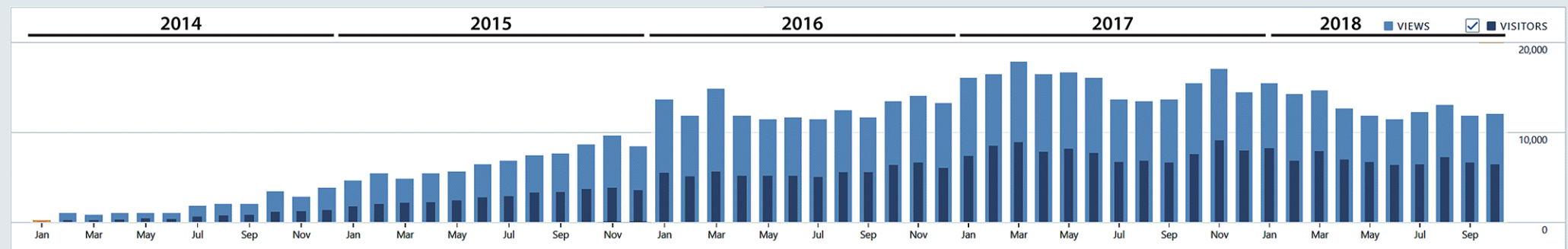
- 1) **Technical how-to guides** detailed build instructions & calibration procedures.
- 2) **Narratives** on the challenges of fieldwork & progress updates.
- 3) **Classroom resources** for adopting the Arduino platform in STEM curricula.

This project is hosted on the free WordPress.com platform. Search engine optimization (SEO) was not performed and promotion efforts focused mainly on electronics hobbyists (Arduino.cc, reddit/r/arduino, Quora, etc).

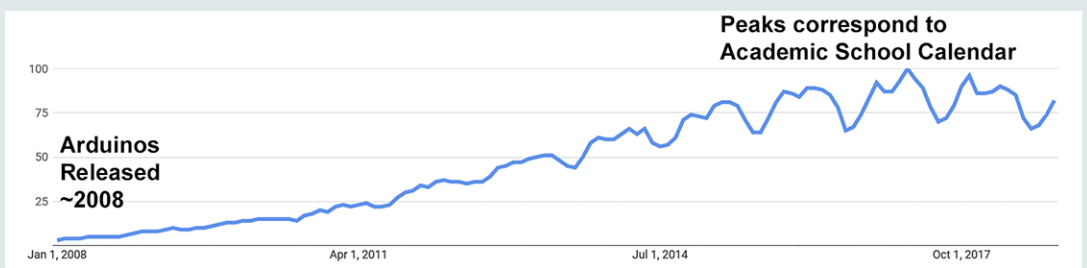
CPP.org is a case-study on the attention and impact that minimally resourced projects can achieve: testing the idea that “If you build it, they will come”.

### >80k visitors/year, educational audience

>260 000 unique IP visitors over 4.75 years. Average 2.1 page views per visit.  
Traffic increased 2014-15 with major additions of content. 200-300 unique IP visitors/day mid-2016.



Seasonal traffic parallels global Google searches for the Arduino prototyping platform, with an annual “double hump” matching the North-American / European academic calendar.



### Google Search >> Social Media

86% of traffic arrives from search engines, compared to 12% from referral links. Direct visits by entering address are negligible. Search terms were directly related to the project matter (eg: Arduino+data+logger, Arduino+sensor, Arduino+data+acquisition, etc.), followed by variations on the names/types of sensors described in specific tutorials.

Referral visits originated from Social Media (SM) sites like Pinterest, and from forums that the authors contribute to. Maximum 1-2% of the total site traffic arrived from each of the major SM channels.

Significant effort was invested to place distributed content on various tech/hobbyist communities (Wevolver, Hackaday Projects, hackster.io, Arduino.cc, github), and these “satellite” resources reached many thousands of viewers within their host environments. **Satellite content however failed to generate click-through traffic back to CPP.org.** We postulate that users of these membership-based sites are ‘siloed’, and feel little need to seek information elsewhere. Login barriers may even have reduced the impact of those BI resources, as search engines are sometimes prevented from indexing content on those sites.

### “Enabling” content gets more traffic

The majority of CPP.org traffic from organic searches is in contrast with many other BI projects. The *Canopy in the Clouds* (~20k/yr) found that content alone was insufficient for discovery via search engines, and, that additional resources were needed to drive traffic via social media (Goldsmith et al., 2014).

Some of the content categories on CPP.org saw dramatically different amounts of traffic, suggesting one possible explanation why this project has been more successful in obtaining organic traffic than other outreach projects.

The technical guides and teacher resources help people perform tasks they are already interested in. Those information seekers are “self-primed”, and so can effectively find learning resources via search engines.

The fieldwork narratives “inform” about a subject which they may not have been previously aware. How can people search for what they don’t know?

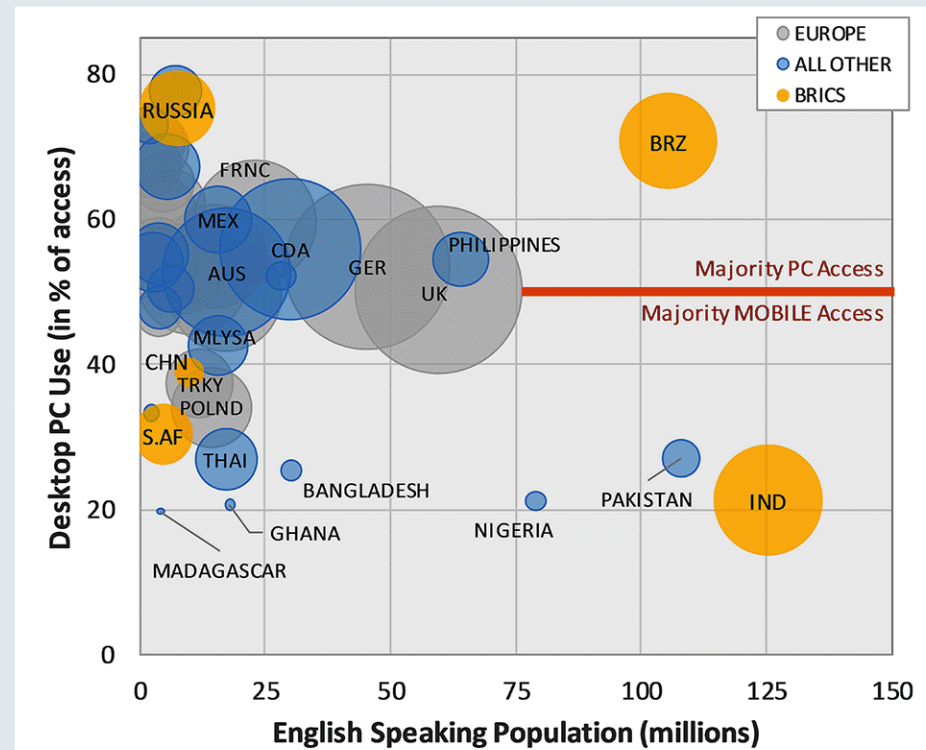
Average Daily Unique IP visits per Page:	2014	2015	2016	2017	2018	Overall
1) Technical How-to Guides (Advanced)						
Using a \$1 DS3231 Real-time Clock Module with Arduino	10	36	47	30	20	29
A DIY Arduino data logger for \$10 from 3 components	8	21	35	41	28	27
Measuring electrical conductivity with Arduino				14	27	21
Using an MS5803 pressure sensor with Arduino	3	16	26	28	19	18
How to Configure I2C Sensors with Arduino Code				22	8	15
2) Fieldwork Narratives & Progress Reports						
Secure Digital Media (SD) card high sleep-current problem solved!	1	2	3	3	1	2
Developing an Arduino weather station...		1	1	2	2	2
In the beginning... Part 1 (linked from the home page)	1	1	2	1	0	1
A New Drip Sensor for Cave Research	1	1	1	1	0	1
Field Report 2016-07-09: I2C sensors work on 20m long cables!				1	1	1
3) Classroom Resources for Teachers (& beginners)						
Arduino UNO Datalogger Project for Beginners		38	67	32		46
Starting Points & Ideas for your Arduino STEM Curriculum				13		13
Tutorial: Adding Sensor Modules to Your Arduino Data Logger				13	11	12
Tutorial: Arduino UNO Serial Plotter for Live Data Acquisition			5	15	12	11
Build your own Arduino Starter Kit for the Classroom		4	3	2		3

Facebook/Instagram/Twitter/etc may be necessary with such “previously unknown” information, especially when content includes strong visual narratives, as many users search for this type of novel input via SM. (Hitlin, 2018).

It may even make sense to host visual narrative content entirely on SM platforms. Since mid-2018 these narratives from the CavePearlProject.org have been migrated to Twitter.

### Global Barriers: Language, PC vs Mobile

CavePearlProject.org traffic generally corresponds with number of English speakers, but only in countries where the majority of internet access is PC based.



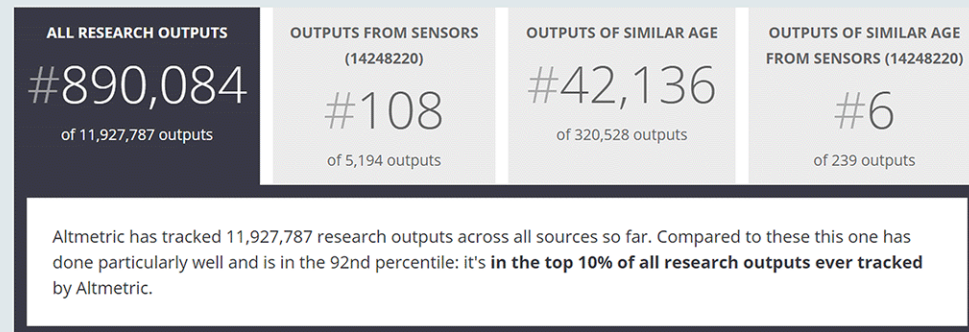
The activity-based tutorials which dominate CPP.org traffic likely create a division between “sit down” vs “stand up” audiences. This may relate to the Arduino microcontroller requiring a USB tether for programming.

**This raises the troubling possibility that developing countries may be less likely to benefit from inexpensive open-source technologies, and the “hands-on” learning resources designed to support them.**

### Do BI efforts support research & teaching?

Academic culture is not yet structured to reward BI activities (NABI, 2018), so these efforts can only be sustained if they are designed to deliver other utility paybacks via tight integration with pre-existing research/educational activities. While the CavePearlProject.org the project’s primary public outreach, the site also serves as a supplemental resource for Dr. Beddows EARTH360 instrumentation and field methods course at Northwestern University. This partly offsets the time required to update and maintain the information.

Although research to date is critical of the ‘academic value’ of social media based Altmetrics (Sugimoto et al. n/d), leading journals embrace this form of promotion. Indeed, this project’s first formal paper (Beddows & Mallon, 2018, in Sensors) has achieved an exceptional Altmetrics score.



This is enhanced by referrals from links on the CPP.org website, and has created positive feedback leading to the project’s recognition as a significant contribution to the Maker’s Movement by other tech sites. Other Arduino-based research publications also achieve excellent Altmetrics scores, so this may be a case of the fitness of the open source hardware content to the internet medium, and the overall DIY message.

It remains to be seen if excellent Almetrics will translate into significant academic citations, and it may also be too early identify the project’s other effects for several reasons:

1) Decline since mid-2016 in searches for Arduino in the U.S. (which is a divergent trend compared to global) and this decline is reflected in CPP.org traffic. This may be due to saturation of the US market, and/or replacement by other emerging platforms like the Raspberri Pi or esp8266.

2) Time is required DIY instrument builders to reach proficiency suitable for real world deployments, and years to gather environmental data suitable for publication. After >4 years, we are only now seeing traffic from x.edu referrers, however other researchers are beginning to adopt these loggers for their own research.

### In Summary

Climate change research highlights an issue that outreach projects need to address: “Members of the public with the highest degrees of science literacy and technical reasoning capacity were not the most concerned about climate change. Rather, they were the ones among whom cultural polarization was greatest ” (Kahan et al., 2012). Those findings suggest that the “informational” resources developed to address that topic are not having the intended effect, and that outreach material needs to go beyond merely communicating the outcomes of scientific research. **Resource formats which are “enabling” can achieve substantial amounts organic traffic because that type of material is self-priming for discovery via search engines.** Resources leveraging technologies that are still maturing, and/or require PC-based infrastructure have confounding factors which could make it challenging to demonstrate merit criterion using simple traffic analytics within typical 3 year project review time frames. Despite these limitations, further BI experimentation is warranted and these efforts can be accomplished by projects with modest resources.

**Cave Pearl Project:**  
<https://thecavepearlproject.org/>

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Data Sources:  
Traffic information from the Jetpack analytic plugin included with free WordPress service.  
Global Search data from Google Trends  
English Speaking population [https://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_English-speaking\\_population](https://en.wikipedia.org/wiki/List_of_countries_by_English-speaking_population)  
Broadband and Mobile statistics <http://gs.statcounter.com/platform-market-share/desktop-mobile-table>