Aligning interests: Integrating Citizen Science Efforts into Schools Through Service Requirements.

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Abstract

Citizen science is an increasingly valuable tool for both scientists and educators. For researchers, citizen science is a means of more quickly investigating questions which would otherwise be time-consuming and costly to study. For educators, citizen science offers a means to engage students in actual research and improve learning outcomes. One of the biggest challenges for citizen science projects is recruitment, and students represent a potential solution to this issue. Since most citizen science projects are usually designed with research goals in mind, many lack the necessary educator materials for successful integration in a formal science education (FSE) setting. In an ideal world, researchers and educators would build the necessary materials together; however, many researchers lack the time, resources, and networks to create these materials early on in the life of a citizen science project. For resource-poor projects, we propose an intermediate entry point for recruiting from the educational setting: community service or service learning requirements (CSSLRs). Many schools require students to participate in community service or service learning activities in order to graduate. Although the merits of making volunteer contributions mandatory for students is the subject of much debate, this requirement still exists for many students creating a need for quality volunteer opportunities. With the help of a volunteer fulfilling a CSSLR, we investigated the need for quality volunteer opportunities created by CSSLRs in San Diego county (where there are no state-mandated CSSLRs), compared with other known locations with municipally-set or state-set CSSLRs, examined the explicitly-stated motivations for having CSSLRs, and explored how citizen science projects--even virtual ones, like Mark2Cure-- might meet the needs of students fulfilling CSSLRs.

Introduction

Citizen science is a growing practice which involves inviting anyone with an interest in science to contribute to scientific endeavors, and has become an increasingly valuable tool for scientists and educators alike (Bonney et al., 2009). For researchers, citizen science offers a way to collect granular data from broad geographic areas over time, sort and analyze large datasets quickly, and ultimately expand scientific knowledge (Raddick et al., 2009). For educators, citizen science presents a unique opportunity to involve students in ongoing scientific endeavors (Haines, n.d.) and provides a forum for engaging in scientific inquiry (Trumbull et al., 2000). The contributions from citizen scientists is central to any citizen science project. To improve recruitment and retention of volunteer contributors citizen

science researchers have studied the motivations of citizen scientists and found that learning and helping are common motivators for volunteer (Newton et al., 2014)(West and Pateman, 2016) and online citizen science engagement (Cox et al., 2017). Motivating factors like learning and helping appear across different citizen science efforts; however, the importance of these motivators vary greatly from project to project and may change over time (Land-Zandstra et al., 2015)(Geoghegan et al., 2016)(Raddick et al., 2013). Nonetheless, for citizen science projects facing recruitment issues, adding educational support may help to capitalize on the learning and helping motivations. Although many projects were not originally designed with an educational goal in mind and educational support in citizen science projects remains highly variable, limited informal learning has been observed in association with citizen science (Brossard et al., 2005)(Masters et al. 2016). Furthermore, the high potential value of applying citizen science towards informal science education warranted the development of a framework which aligns the needs of stakeholders from citizen science and informal science education (ISE) (Shirk et al, 2012).

In addition to motivation issues, many citizen science projects have a diversity problem when it comes to the volunteers they are able to recruit (Land-Zandstra et al., 2015). Environmental volunteers are less likely to come from lower income or be of ethnic minorities backgrounds. In the interest of reaching and engaging a wider and more inclusive audience in science (democratizing science) and fulfilling their own recruitment needs, citizen science researchers are looking for ways to successfully incorporate citizen science into formal science education (Shah and Martinez, 2016) (He and Wiggins, 2017). The administrative burden for incorporating citizen science into formal science education can be high considering entry barriers such as: limitations in project resources (He and Wiggins, 2017); dependence on technological availability (Mueller, Tippins, and Bryan, 2012) (Silva et al., 2016); and limits in educator access to scientific materials (Gray, Nicosia, and Jordan, 2012), expertise (Bonney et al., 2015) and time (Silva et al., 2016). In spite of these barriers, citizen science projects have been successfully integrated into the classroom setting (Butler and MacGregor, 2003)(Gray, Nicosia, and Jordan, 2012). Successful integration of citizen science projects in the classroom requires meaningful interactions between educators and scientists to resolve differences in stakeholder priorities (Zoellick, Nelson, and Schauffler, 2012) and the generation of educational resources. Scientists need to work with educators to create educational resources, yet many educators are under severe time constraints which makes them difficult to recruit without already having educational resources in place. To bypass this chicken-and-egg problem of educator and educational material, citizen science projects can utilize a third entry point into the educational environment: community service or service learning requirements (CSSLR).

Community service is a voluntary non-curriculum-based activity that may be recognized (and in some cases, required) by schools and generally does not have explicit learning objectives. In contrast, service learning is a curriculum-based community service activity that has explicit learning objectives (Spring, Grimm Jr, and Dietz, 2008). In the United States, twenty nine states have policies in place to encourage community service or service learning at the high school level (Ecs.force.com, 2014), and many schools have community service or service learning requirements regardless of state policy because of their reported merits (Vogelgesang and Astin, 2000)(Celio, Durlak, and Dymnicki, 2011). Since many citizen science projects are run by nonprofit organizations, are regional (park-based wildlife surveys, regional pollution tracking) or have important implications for health and quality of life (air quality monitoring,

disease research), it makes sense to align citizen science opportunities with community service and service learning needs.

Mark2Cure is a citizen science project in which contributors extract knowledge from biomedical text in order to facilitate the search for insights on curing diseases (Tsueng et al., 2016). It is currently focused on literature surrounding a rare disease called NGLY1-deficiency. As with many citizen science projects, Mark2Cure has great potential as an educational tool, but has not yet developed any resources for educators. Furthermore, Mark2Cure is an online citizen science project and therefore subject to the technology access limitations mentioned by Geoghegan et al., making FSE integration challenging. Mark2Cure receives a lot of inquiries from students through its listing on VolunteerMatch. Many of these students approach Mark2Cure because of community service requirements imposed by their schools, but it is difficult for Mark2Cure to provide the verifications students need in return for their contributions.

In this paper we aim to aim to share data on a means of increasing student recruitment outside ISE and FSE routes as a temporary/stopgap solution until educational resources can be developed. With the help of a volunteer recruited because of service requirements, we inspect the prevalence of CSSLRs in San Diego to gauge potential audience size. We align incentives for citizen science and CSSLRs and provide guidance on how citizen science efforts can be tweaked to meet CSSLRs.

Methods

Overview of the High School CSSLR Landscape at different levels of government

There are a limited number of examples of high school CSSLRs set outside the individual school or school district level. At the city-wide level, Chicago and Washington DC are examples of cities with CSSLRs, and we pulled data on Chicago's high school CSSLRs from the Chicago Public Schools Policy Manual (Chicago Board of Education, 2017). At the state level, Maryland is the only state to have statewide high school CSSLRs in the US, and information on Maryland CSSLRs were obtained from the Maryland State Department of Education Policy (Code of Maryland Regulations, 2016). There are no other statewide high school CSSLRs in the US, but Canada provides an example of provincewide high school CSSLRs. High school CSSLRs from Ontario were obtained from the Ontario Schools, Kindergarten to Grade 12: Policy and Program Requirements (Ontario Ministry of Education, 2016). High school enrollment data were obtained from Chicago Public Schools (Cps.edu, 2018), Department of Planning Maryland State Data Center (Mdp.state.md.us, 2016), and Ontario Education Facts (Ontario Ministry of Education, 2017). Data on Maryland community service participation was obtained from Maryland State Department of Education (Marylandpublicschools.org, 2017), but was estimated for Chicago and Ontario by averaging the requirement over the four years expected for high school students and multiplying by the number of high school students.

Surveying the High School CSSLR Landscape in San Diego

A list of public San Diego high school districts, high schools, and the 2016-2017 student enrollments at each school were obtained from the California Department of Education (Ed-data.org, 2018). CSSLR requirements for each school were investigated via school or district-specific website searches and inquiries by phone or email. For schools with no CSSLRs, we investigated Junior Reserve Officer Training Corps (JROTC) programs and/or Key clubs, both of which tend to have community service requirements. Key club membership estimates were based on the Key Club International Paid Clubs Report for the 2016-2017 school year available from the Kiwanis International website (Kiwanis.org, 2017). These numbers account for only due-paying members and may underestimate the actual membership since payment of dues is not needed for participation and volunteer activities in some schools.

Quantifying student engagement in CSSLRs in San Diego

Rough estimates of students engaged in CSSLRs were obtained as follows:

1. If school a school has CSSLRs, the number of students engaging in CSSLR was assumed to be 100% and therefore the number of students enrolled in that school was used.
2. If a school does NOT have CSSLRs, any estimation on student participation in volunteer activities provided by the schools was used.
3. If a school does NOT have CSSLRs or estimates on student participation in volunteer activities, the school was checked for the presence of Key Club or a JROTC program. The memberships in both programs were estimated and the number of volunteers was assumed to be the higher membership of the club/program.
4. If a school does not have CSSLRs, estimates on student participation, key club or JROTC, it was treated as not estimateable.

Qualitative inspection of the rationale for CSSLRs and community service recommendations/mentions, verification methods, and qualifying activities.

The websites and student/parent handbooks (publicly available materials) of all schools in this study were inspected for any mention of community service. If community service was mentioned on the school's publicly available materials, the content was inspected for language that encouraged or recommended engaging in community service. If the school mentioned, endorsed or recommended engaging in community service:

1. The reasons/rationale given for the mention/endorsement were qualitatively binned into thematic categories, with new categories added whenever a rationale did not fit in with an existing one. An example of the qualitative binning process can be found in Supplementary figure 1. The final list of categories is as follows:
    a. Admissions: Because college admissions
    b. Connection: Foster civic responsibility and community/engagement, relationships
    c. Skills: Learn/build skills
    d. Humanitarian: improve community/school/help neighbors
    e. Character: build esteem, good feels, character

   f. Experience: real life experience
   g. Merit: qualify for award, association, guaranteed admission, IB qualification etc.
   h. Fun: for fun/interest/passion
   i. Requirement: particular/specific class requirement
   j. Intervention: Intervention / penalty
2. The school's website was also searched for the availability of a sample tracker, log, form, or other guidelines for verifying a student's participation in community service activities.
   a. If a tracker, log, form or other guideline could be found, the fields on that tracker, log, or form were documented.
3. The school's website was checked for sample activities which qualified vs didn't qualify as community service activities, and the sample activities were recorded and binned.

Surveying the Citizen Science Landscape in San Diego

San Diego his home to a regional Citizen Science network and has held an annual citizen science expo since 2016. Citizen science projects/organizations that have been invited to or have participated in the citizen science expo were inspected for the organization type and non-profit status.

Aligning Mark2Cure Metrics with CSSLRs

We collected annotations from Mark2Cure's NER missions completed between 2015.05.01 and 2017.11.22. Annotations that were marked by at least 6 users were used as the reference set. Abstracts in Mark2Cure vary greatly in the difficulty and there is a large learning curve to become proficient at the task. Assuming that both factors affect the amount of time it takes for a user to completely mark a document and that users with more experience will completed the task at a more stable rate, we identified contributors to Mark2Cure who have annotated over 50 abstracts. We calculated their precision, recall, and f-score for their annotations with respect to the reference set. We also looked for successive submissions on a per user basis to estimate the time spent per submission and calculated the mean, median, minimum, and maximum amount of time (in minutes) spent per abstract. Abstracts which took longer than 45 min were presumed to have included some sort of break/distraction and were exclude from the time calculations. After obtaining user performance and time metrics, we binned the users by their f-scores and averaged the time metrics for each range/bin of f-scores.

Assumptions and Limitations

Estimates are based on simple assumptions are expected to provide ballpark figures for a snapshot in time. While student enrollment numbers in schools would ideally reflect the number of students served at those schools, the reality is more difficult to account for as students may drop out, transfer, double-enroll, enroll part-time, graduate early, graduate late, etc. Hence, although the number of students enrolled in a school that has CSSLRs is assumed to be the same as the number of students at the school who engage in CSSL, this estimate is expected to provide more of a ballpark figure than an

accurate count.

Results

Hours of Quality Opportunities Needed by Students with CSSLRs

In the US, CSSLRs have been set at the state level (Maryland) and city level (Chicago) as well. Maryland high school students are required to complete 75 hrs of community service; while, high school students in Chicago are required to complete 40 hrs. In Canada, CSSLRs may be set at the province level such as in Ontario.

Table 1a- Examples of CSSLRs at different levels of government

Location	Country	Level	CSSLR	2016 high school enrollment	Estimated hours needed/year
Chicago	US	City	40 hrs	109,053	1,090,530
Maryland	US	State	75 hrs	255,624	6,643,377*
Ontario	Canada	Province	40 hrs	635,759**	63,575,906

*Actual number of community service hours recorded for 2016-2017, but may include community service contributions middle school students. **Values for 2016-2017 not available, so 2015-2016 numbers used instead.

In San Diego county, only two high school districts have district-wide CSSLRs: Sweetwater Union and Fallbrook Union. Outside of these two districts, some districts provided no restrictions allowing schools to impose their own CSSLRs. Even if a school did not have strict CSSLRs in place, there were student organizations and/or programs that have CSSLRs such as Key Club, National Honor Society, JROTC, and other programs that could be used for estimating the minimum number of students in need of volunteer hours at each school.

Table 1b - Summary of CSSLR data in San Diego County

# of schools that		# of students	# of volunteers/yr	Total hours/yr
Total number of schools	105	146104	65093	--
--Require community service	29	48773	48773	600,261
--Have partial requirement	3	2345	1173	--
--Don't require, but provided data or estimates	14	27632	12066	--

--Don't require, but have key clubs	50	88242*	2861*	17,451*
--Don't require, but have JROTC programs	23	50555*	2879*	**
Schools with no data	14	4780	--	--
Schools part of multi-school campus otherwise already counted	8	4161	--	--
				617,712

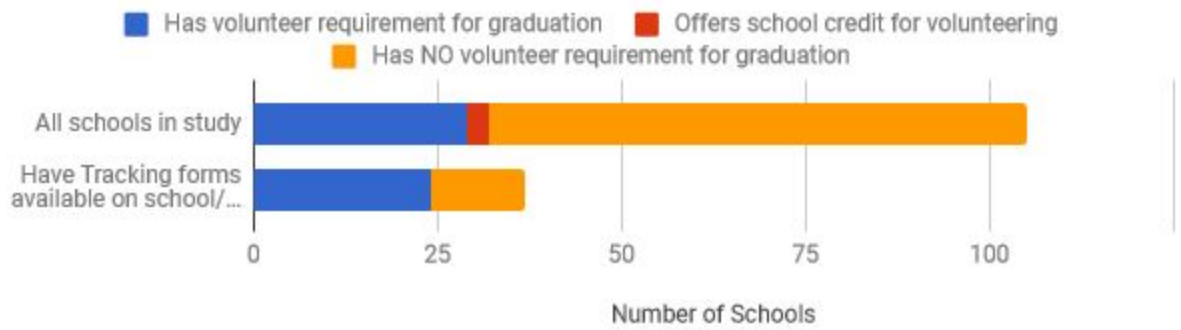
*These values not mutually exclusive since students may be participate in both. **JROTC volunteer hours can be set at the program-wide level instead of at the individual student level and can vary from school to school.

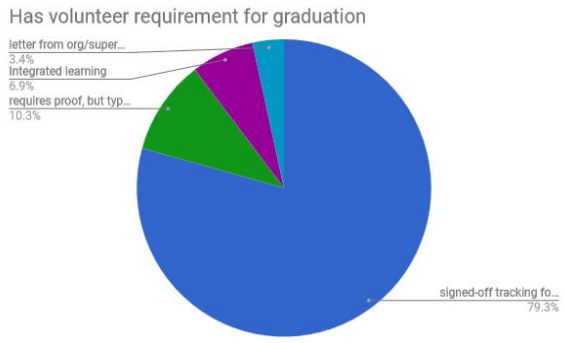
According to data from the California Department of Education (Ed-data.org, 2018), there were 158,733 high school-aged students enrolled in public schools across San Diego county in the 2016-2017 school year. Of those students, 146,104 were enrolled in one of the public schools investigated in this study, while the remaining students were enrolled in schools excluded from the study due to the 'non-traditional' nature of the school (e.g., strictly online, or caters primarily to another age group.) One third of students in public schools across San Diego county (48,773) had a CSSLR to fulfill, and contribute 600,261 hours of community service annually. Across four years, these students will contribute an estimated 2.4 million hours of community service.

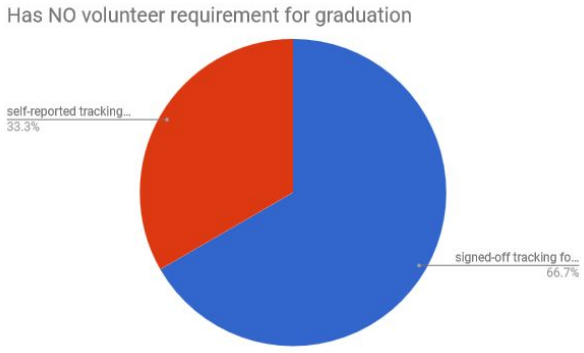
Even without a CSSLR in place, about 43% of the students in schools that collected data or provided estimates on student volunteerism engaged in community service activities. Assuming that students in participating in JROTC or Key club also engage in some form of community service, the number of San Diego County students in need of quality community service/volunteer opportunities rises to about 65,093. As seen in Table 1a and 1b, CSSLRs create a need for quality volunteer and community service opportunities. Citizen science participation may be able to meet those needs if the citizen science activities qualify as community service activities. To determine how citizen science organizations and efforts could fulfill CSSLRs, we investigated how CSSLRs and community service recommendations in San Diego County were tracked and/or validated.

CSSLR and Community Service Validation Methods

Figure 1-







Although only 29 out of the 105 schools had CSSLRs, only 24 of those 29 schools provided some sort of tracking form or some sort of guidance on the acceptable proof for meeting the CSSLRs. For 5 schools, no form or guidance could be found. For 3 of the 5 schools, the CSSLR was integrated (service learning) into the curricula. Although the majority of schools did NOT have a CSSLR, some schools still provided tracking forms on their websites, and tracked student volunteering activities in order to verify a student's eligibility for various scholastic programs (e.g., Presidential Award, National Honor Society, CJSF, etc.)

Of the schools that did provide some sort of means for tracking CSSLR fulfillment, most schools opted for some sort tracking form that could be signed off by a supervisor (or parent if necessary). Self-reporting trackers (no signature needed, but contact info should be included) were available from some schools without CSSLRs. CSSLRs were almost exclusively determined by time spent engaged in community service activities (minimum number of hours); therefore, citizen science efforts must be amenable to providing time metrics in order to engage participants fulfilling CSSLRs. To understand how citizen science efforts could appeal to students fulfilling CSSLRs, we analyzed the justifications and rationales that San Diego County high schools gave for engaging in community service activities.

Justification for CSSLRs and Rationale for Engaging in Community Service

Figure 2-

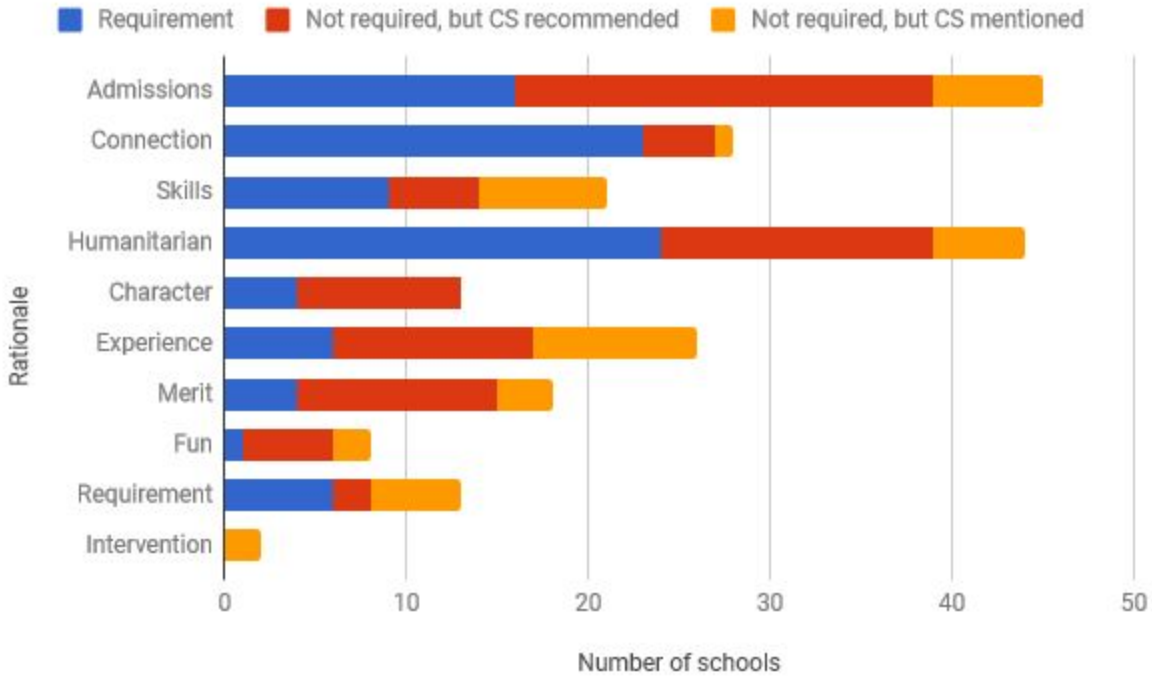


Figure 2- The frequency of a particular category of rationale cited in support of schools that had CSSLRs (blue), did not have CSSLRs but recommended community service (red), and did not have CSSLRs but mentioned community service (orange). Admissions were mentions of college admissions. Connection indicated motivations of connecting the student to the broader community such as fostering civic responsibility and community/engagement, relationships. Skills included learning, applying, or building skills. Humanitarian reasons were those involving improve community, improving the school, helping neighbors and people in need. Character included building esteem, feeling good about oneself, and building character. Experience was just mentions of gaining real life experience. Merit included mentions of qualifying for an award, acceptance into an association, guaranteed admission, IB qualification etc. Fun included fun, hobby, interest, passion. Requirement is NOT the same as schoolwide or club/organization based CSSLRs, but instead refers to community service requirements set for a particular or specific class not necessarily available to all students (e.g., AVID). Intervention includes justifications of community service as a penalty for misbehavior.

Many different rationales were cited in support of CSSLR's (Figure 2). Among those schools with a formal requirement, the most widely-cited rationales were those in the Connection and Humanitarian categories. In contrast, schools which did NOT have CSSLRs, but recommended participation in community service activities tended to focus on Admissions and Humanitarian types of justifications. Experience and Skills were also common categories of justification given for engaging in community service. A few schools mentioned community service strictly in the context of Intervention for at risk students who have broken school rules. The differences in stated motivations for schools with vs without CSSLRs likely reflect the difference in the target audience for those messages. Schools with CSSLRs may be providing their justifications to appeal to parents and the broader community who are stakeholders and decision makers that may impact the schools' policies. In contrast, the schools without

CSSLRs appear to be tailoring their message towards students and parents to encourage student involvement in the absence of any enforcement authority.

In order to appeal to students fulfilling CSSLRs, citizen science projects/organizations should tailor their messaging accordingly. If appealing to students and parents, the messaging should focus on college admissions and the public benefit. If appealing to parents, educators, and school administrators, the messaging should focus on public benefit and relationship building/community engagement. To determine whether or not citizen science efforts in San Diego County would qualify to fulfill CSSLRs, we analyzed the definitions, examples, and areas of impact of community service provided by schools with CSSLRs and inspected how San Diego-based citizen science efforts aligned with those definitions and areas of impact.

Definitions of Community Service--Basic Qualifications for Citizen Science Projects to meet

Many schools encouraged students to engage in community service and even provided verification forms; however, guidelines and examples on what counted as community service were fewer in number and tended to come from schools with CSSLRs. Only six unique examples/guidelines on community service activities were found. The non-community service (Not CS) and community service (CS) activities from the six examples were aggregated as seen in Supplemental Table 1.

In general, an activity counted as community service if it meets all of the following criteria:

1. Activity is done under adult supervision of someone outside of the family / Activity can be verified by someone outside of the family
2. Activity is done in conjunction with non-profit organization that benefits community
3. Activity is done without payment
4. Activity is done outside regular school hours or typical extracurricular activities (such as school sports fundraising)
5. Activity actually helps others, is not just a meeting or talking about helping.

We examined several citizen science efforts based within San Diego County (Supplemental Table 2) to determine compliance with these community service criteria. 100% of the 32 San Diego organizations/institutions that sponsored over 40 citizen science projects inspected were non-profit organizations or government institutions. Academic institutions included universities and higher education research institutes like the University of California, San Diego and The Scripps Research Institute. Although only 4 academic institutes were counted, some institutes had multiple research groups running different citizen science projects. Government agencies with citizen science projects in San Diego included the Department of Fish and Wildlife services (Invasive species monitoring), the Department of Vector control (vector/public health monitoring), and the NOAA (ocean biodiversity). All three STEM education organizations (such as San Diego Children and Nature, the Earth Discovery Institute), engaged in diverse citizen science efforts to further STEM education. Citizen Science conducted by environmental coalitions and agencies such as the Beach Ecology Coalition, I love a Clean

San Diego, San Diego Coastkeepers, and others tended to focus on ecological health and biodiversity as did many of the projects coming out of Parks/Park foundations (e.g., San Dieguito River Park Conservancy, San Diego River Park Foundation) and specialized societies (e.g., San Diego Audubon Society, San Diego Chapter of the California Native Plant Society).

Volunteering for these organizations would meet the non-profit criteria for community service, but not all of the citizen science activities coming from these organizations could be justified as community service activities. For example, there are two passive distributed computing projects (FightAids@Home, Outsmart Ebola) in which 'volunteers' donate computer time, but not actually their time--hence it likely wouldn't even be counted as an activity at all. The majority of citizen science activities likely would qualify if its importance to the public were properly conveyed and if it was performed under appropriate supervision.

San Diego County is a region of high biodiversity, and many of the citizen science projects in the region are geared towards learning what lives in the region (biodiversity projects) and monitoring ecological health either directly (pollution, water quality) or indirectly (key species/biodiversity monitoring, biodiversity monitoring). Many park-based organizations already have ties with schools to encourage students to engage in their volunteer habitat restoration and trail maintenance efforts and may leverage these relationships for citizen science recruitment. Organized community cleanups (e.g., beach cleanups) are already acknowledged as community service activities (supplemental Table 1). These cleanup activities usually include additional data collection (type of trash, location of trash, etc.) illustrating a natural alignment between citizen science activities impacting ecological health and community service activities. Projects like Democracy Counts which investigate electoral fairness naturally align with volunteer community service activities aimed at civic engagement such as unpaid campaigning and poll work.

Aligning Contribution Metrics in Mark2cure with CSSLRs

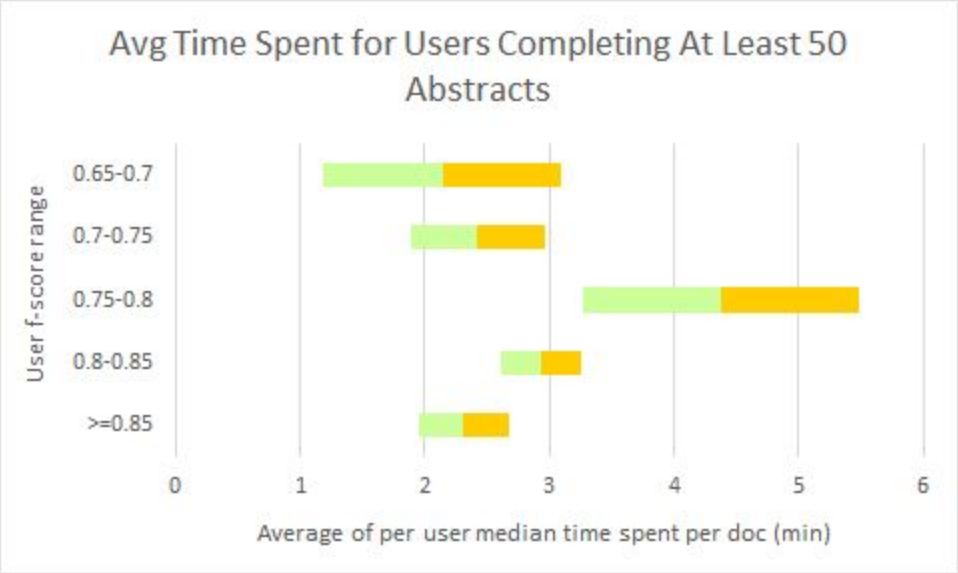
Mark2Cure is a citizen science project aimed at organizing biomedical knowledge to facilitate disease and treatment research to ultimately improve patient outcomes. Although helping patient populations is an acknowledged community service activity and naturally aligns with Mark2Cure, Mark2Cure is an online platform and does not readily suit the needs of students in need of community service opportunities. Schools generally measure community service contributions in terms of hours, while virtual citizen science projects like Mark2Cure tend to measure contributions in terms of classifications, annotations, submissions, etc. In order to empower students to fulfill their obligations while contributing to a citizen science project like Mark2Cure, we need to align our contribution metrics with those acceptable by schools and provide an easy way of verifying their efforts.

Volunteer and citizen science contributions through Mark2Cure are time stamped, allowing successive contributions from the same user to be used to estimate the time that user spent on a task. The use of this timestamp to estimate the time a contributor spends on an task is problematic for two reasons:

1. It can be very inaccurate. Estimating time spent on a task based on the difference between timestamps of a contributors successive submissions will include time they simply left the task open.
2. It does not reflect the true value of the contributor's submission. A contributor's submission is most valuable when they try to do the task correctly.

Another solution would provide a simple conversion factor to convert number of contributions into time; however, this conversion factor could incentivize students to work quickly without regard for quality. To correct for this, we analyzed our contributions to create a scaled conversion factor.

Figure 3 - Time vs NER quality in Mark2Cure



The average time spent per abstract is represented by the line between the green and orange bars which represent the lower (green) and upper (orange) standard error of the mean.

On average users performing at a level of 0.75-0.8 spend a median of 4.4 minutes per abstract. User performing at even higher levels (>0.8) spend even less time per abstract, presumably because increased expertise decreases the time needed to perform a task well. Based on this analysis, Mark2Cure could apply a scaled conversion factor that would reward students to perform at higher levels. For example, each abstract completed at a level of 0.75 or above would count at 5 minutes of volunteer time. Abstracts completed at a level of 0.7 to 0.75 would count as 3 minutes of volunteer time; while, abstracts completed at a level of less than 0.7 would count as 2 minutes of volunteer time. In this manner, students are incentivized to contribute higher quality annotations over lower ones.

To ensure that these conversion factors were reasonable, we selected two high school students who contributed annotations on over 100 abstracts and calculated their individual performance and time metrics. Both students had f-scores of above 0.8 relative to the reference set. The median amount of time spent per abstract by each of the students was 1.6 and 3.6 minutes--averaging 2.6 minutes, which is within the lower standard error of the mean for the corresponding user f-score range. Users with

average f-scores below 0.65 relative to the reference set generally did not contribute at least 50 abstracts and were not included.

As an online platform, the conversion of Mark2Cure metrics and population of a CSSLR log/form could potentially be automated. To determine the fields that would be important for such a process, we documented the fields available in the 25 different CSSLR logs/forms/trackers found from school websites in San Diego County (Table 2). Schools in districts with CSSLRs were assumed to use the district-wide forms which were counted only once for each district.

Table 2 - Verification form field frequencies

Data Category	Tracking form data fields	Totals
School	School Preauthorization required?	5
	Parent Preauthorization required?	4
	Teacher/Advisor/school rep name	4
	club/org	2
Student	Student name	25
	Student ID	11
	Student expected year of graduation	5
	student grade	8
	school year	4
Organization	Service site / sponsoring org name	19
	Business card or letter on letterhead	2
	sponsoring org website	3
	Location / Place of service	12
Activity	Day / Date	24
	Event	2
	Activity description	23
	time start	9
	time end	9
	Number of hours	25
Supervisor	supervisor name	19
	supervisor contact info	19
	supervisor position	7
	Supervisor signature	21
	Supervisor initials	2
	supervisor comments	2

Reflection	Reflection on activity	2

The most common fields on the verification trackers/forms/logs provided to these students were the Student's name, the name of the sponsoring organization, the location of the community service activity, a description of the activity, the date the student participated in the activity, the number of hours spent on the activity, the supervisor's name, contact info, and signature. Some forms requested more granular details about the student, organization, activity, or supervisor.

Recommendations for Aligning Citizen Science Projects with CSSLRs

Based on the results of our investigation, we provide the following recommendations to citizen science projects for aligning with CSSLRs:

1. Citizen science project goals should be framed in terms of the 'big picture' public good, and the messaging should emphasize how the project engages the student with the community it serves as well as the value of these experiences for college applications. For example, mycological biodiversity efforts may want to emphasize the value of a student's contributions to this scientific endeavor, the importance of fungi to ecological health, and the impact of ecological health has to a community's economic and physical wellbeing.
2. Citizen science projects should associate with the non-profit entities that sponsor them. CSSLRs generally must be fulfilled by contributions to a non-profit organization; hence, if a citizen science project is born under a for-profit and non-profit partnership--the non-profit association should be emphasized.
3. Citizen science projects need to document and provide time/temporal feedback. CSSLRs are almost exclusive time-dependent requirements, so projects that forsake time measurements for quality metrics must find a way to accommodate.
4. Citizen science projects should have a team member or coordinator available for answering questions from students, tracking/verifying student participation, and providing necessary validation (such as signing forms).
5. Citizen science projects need to be findable by students seeking to fulfill CSSLRs. Citizen science projects should contact local schools to get listed on school websites (if available), and be added to volunteer listing sites/matching services like VolunteerMatch.org and AllForGood.org.

Discussion

Volunteerism has been extensively studied in the context of education and service learning. The merits and disadvantages of having CSSLRs (mandating volunteerism) in schools is subject to ongoing research and debate (Helms, 2013)(Kim and Morgül, 2017)(Bode, 2017) and is beyond the scope of this paper. However, citizen science is a volunteer-driven activity, and research on citizen science inevitably will intersect with research on volunteerism. In fact, citizen science participants are still frequently referred to as volunteers in spite of potentially negative connotations with the term (Eitzel et al, 2017) and citizen science practitioners have been taking cues from the study of volunteerism (West & Pateman,

2016). Even resources which were once distinctly in the citizen science space, such as SciStarter.com (an index and matching site in the citizen science space similar to VolunteerMatch.com in the volunteer space), has moved into the volunteer space and now provides data on citizen science projects to allforgood.org, a volunteer indexing and matching site (Cavalier, 2016).

Citizen Science is already an acknowledged tool for ISE (Shirk et al. 2012) and practitioners have been actively investigating its integration in FSE. The gap between ISE and FSE can be difficult for citizen science project leads to overcome without sufficient resources. Research from the of science education field suggests a middle ground (Non-Formal Science Education, NFSE) which could bridge the gap. This middle ground, NFSE, is described as typically having some structure, being prearranged, usually voluntary (thus primarily being intrinsically motivated, but not always), occurring at an institution outside of schools (such as museums, zoos, aquariums, etc), and where learning is not usually evaluated strictly (Eshach, 2007). The characterization of NFSE is primarily used to explore science learning in the context of museum/zoo field trips or mobile museums/zoos, but could just as easily describe CSSLRs applied to a scientific endeavor. Hence, the fulfillment CSSLRs with citizen science participation could be considered a form of NFSE and serve as an important bridge for projects interested in FSE integration.

Wikipedia is a crowdsourced, volunteer-based platform that serves as a good example of a project that has successfully moved from ISE to FSE. In 2012 an educational institute in Mexico, ITESM-CCM, allowed its high school students the option of fulfilling CSSLRs set by the International Baccalaureate Program using Wikipedia editing contributions demonstrating the potential value of CSSLRs as an entry point for crowdsourced, volunteer programs (Thelmadatter, 2012). In 2013 Wikiedu officially spun off of the Wikimedia foundation and provided the support needed for integrating Wikipedia editing into FSE (Wiki Education, n.d.). In 2016 Wikiedu launched the Wikipedia Year of Science 2016 initiative and encouraged the development and adoption of resources for using Wikipedia for FSE (Simons Foundation, 2016). These openly shared, and collaboratively created resources enabled educators to more fully utilize Wikipedia for enhancing student learning outcomes while improving scientific content on Wikipedia (Xia, 2016)(Brooks, 2016)(Wiki Education, 2017).

For citizen science to successfully make a similar transition from ISE to FSE, citizen science organizations will need to establish partnerships with STEM educators interested in the co-creation of educator resources. Until these partnerships are established and the resources developed, CSSLRs set at any level (school, district, city, state, province) create a need for quality community service opportunities that could serve as a much-needed, initial NFSE entry point for citizen science organizations into FSEs.

Conclusions

Given the natural intersections between the fields of citizen science, STEM education, and volunteerism, CSSLRs present an interesting area of investigation. We inspected the prevalence of CSSLRs in San Diego County and at different levels of government and estimated the potential market need created by

CSSLRs. We analyzed the rationale and verification methods used for those CSSLRs and provided guidance on how citizen science efforts can be tweaked to meet them using own platform, Mark2Cure, as an example. In the spirit of citizen science and to extend our knowledge beyond the data we were able to collect in this research, we have added our San Diego County CSSLR data to citsci.org (http://citsci.org/cwis438/browse/project/Project_Info.php?ProjectID=2108) and created the fields needed in order for anyone to collect and contribute data on CSSLRs in their local schools. We hope this data will be useful to citizen science organizations/platforms like Scistarter.com which are becoming an increasingly valuable resource for STEM educators.

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