Table 4. Software infrastructure can enable the capture of valuable metrics for evaluating engagement and impact. Note that there are other helpful tools to enable metric collection. These are simply examples based on the experience of software developers funded by ITCR, for example the developers of QIIME 2 [Bolyen et al., 2019] found metrics from workshops, forums, and other forms of outreach valuable for evaluating community uptake and user experience.

Elements	Options	Tools to Enable Metric Collection	Possible Enabled Metrics	Considerations
Web Presence	Web-based tool	•Cronitor [cro] for tools using cron job scheduling [Peters, 2009]) •Google Analytics [goo, a]	•Identify details about usage •Identify where your tool is being used •Possibly identify what data are being used	May need to consider privacy restrictions for tracking IP addresses.
	Documentation Website	•Google Analytics [goo, a]	•Counts of page views and scrolls	Pages with more views may identify widely used features or confusing aspects.
Citability	Providing something to cite (Software DOI or manuscript) and information on how to cite	•To create DOIs: Zenodo [zen], Dryad [dat], Synapse [syn], and Figshare [fig] •To track DOIs: Altmetric [noa, 2015]	•Total citation counts •Counts of citations by journals of different fields	Semantic Scholar [noa, a] provides reports that indicate where citations have occurred within scientific articles. DOIs are not as persistent as perceived so keeping track of ones DOIs is not only a valuable metric but useful for maintaining manuscripts. Using these platforms can help track open source software and their associate manuscripts.
Contact	Feedback Mechanisms	•GitHub Issue Templates •Surveys	•User feedback count •Addressed user feedback count	Often users will only provide feedback if something is broken. Depending on the tool, many users may not be comfortable with GitHub Issues.
	Discussion Forums	•Discourse [dis] •Biostar [Parnell et al., 2011] •Bioinformatics Stack Exchange [bio] •Google Groups [goo, c]	•Metrics based on user engagements and answered questions	Forums can illustrate the amount of community activity with a particular tool [Howison et al., 2015, Parnell et al., 2011]. They can also save time for development as users help each other instead of developers answering individual emails for repeat problems [Prlić and Procter, 2012]. A code of conduct can help create a supportive community.
	Newsletter Emails	•Mailchimp [mai] •HubSpot [HubSpot]	•Count of newsletter openings •Count of link clicks •Count of unsubscribers	Newsletters can help inform users about new features.
Usability Testing	•Observe a few people use the tool •Discussion Forums	•Zoom screen sharing and recording •Discussion Forums (above)	•Qualitative information about how users interact with your software	Even low numbers of usability interviews (3) can yield fruitful lessons that can be paired with other metrics to guide development. Forums that provide Q&A can identify usability issues and bugs [Howison et al., 2015, Patrick, 2020].
Workshops	•Online or in-person •Basics or new features	•Attendees can participate in surveys	•Quantity, duration, and attendance at workshops are metrics that can be reported to funding agencies	Recordings can be posted on Social Media (for additional metrics).
Social Media	•YouTube Videos •Twitter/ Mastodon •Instagram •LinkedIn	•Hootsuite [hoo] - social media management	•Engagement metrics (video watch counts, likes, etc)	Pairing Social media metrics with software engagement metrics can determine if outreach strategies are successful.
Reviews	Review Forum	•SourceForge [sou] •GitHub	•Stars •Watchers •Forks •Number of reviews	Positive reviews, active community participation, and code review can be reassuring to funders and users alike.

Table 5. Software health infrastructure. Infrastructure that enables collecting metrics about software health can reassure users and funders.

Infrastructure	Options	Tools to Enable Metric Collection	Possible Enabled Metrics	Considerations
Version Control	Without Automation	•Git/GitHub [Git, a] (The insight tab and API allow for systematic metric collection) •Git/GitLab [Git, b] •BitBucket [Atlassian]	•Commit frequency (how often code is updated) •Date of the most recent commit •Number of active contributors •Software versions updates	Commit frequency allows assessment of how actively the software is being maintained. The number of contributors can indicate sustainability. One single contributor may pose a sustainability risk. Version information can enable users to determine if they are using the most up-to-date version.
	With Automations	•GitHub Actions[git] •Travis CI [Tra, 2022] •CircleCI [cir, 2022]	•Current build status (if the software built without errors)	Continuous Integration and Continuous Deployment or Delivery are terms to describe a situation where every time code is modified, the full code product is automatically rebuilt or compiled. Continuous Deployment or Delivery describes the automatic release of this new code to users. Delivery in this case describes situations where the software requires more manual releases while deployment is seamless. GitHub Actions can also help with metric collection from the GitHub API.
Testing	Automated Testing	•GitHub Actions[git] •Travis CI [Tra, 2022] •CircleCI [cir, 2022]	•Test code coverage (the fraction of lines of code in the project that are covered by tests)	Unit tests check individual pieces of code; component and integration tests check that pieces of code behave correctly together; acceptance tests check the overall software behavior. Achieving in-depth test coverage requires careful software design. Test coverage does not evaluate the quality of the test cases or assertions.
Licensing	A variety of licenses exist to allow or disallow reuse and to require attribution	•Creative Commons [cre]	•Possible quantification of reuse of your software code	Clearly indicating if and how people can reuse your code will make them more comfortable to do so. Determining when this is done can be a challenge, but requiring attribution makes this more feasible.