



Gateway Expertise When You Need It: Growing QUBES by Working with the Science Gateways Community Institute

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<https://sciencegateways.org>

The NSF-funded Science Gateways Community Institute (SGCI) provides a variety of services to the community of gateway builders and users. In some cases, gateway clients have benefited from the complete spectrum of services. In this case study presentation, we use the QUBES gateway as an illustration of how SGCI services can support multiple aspects of a project. Specifically, we describe our hands-on consulting services (both software development and usability evaluation), Science Gateways Bootcamp training, inclusion in the Gateway Catalog, the Gateways conference series, and our internship program, and how each element provided different facets of support to the growing QUBES gateway.

About the Client

In March of 2014, the National Science Foundation (NSF) hosted the BIO IUSE Ideas Lab which was designed to support the development of novel, transformative ideas in undergraduate biology STEM education. It was here that Sam Donovan, Jeremy Wojdak, and Tom Gower met and began working on a plan to promote quantitative biology education. In their work at the Ideas Lab, they had come to the realization that supporting faculty collaboration in developing teaching materials would be essential to incorporating quantitative skills development in undergraduate biology classrooms.

Following the Ideas Lab, NSF issued a special call to participants to submit proposals to implement their ideas. They had a month to pull a team together and to submit a grant proposal. Drawing on the work done under the [Research Coordination Networks in Undergraduate Biology Education \(RCN-UBE\)](#) project, Donovan (Biological Sciences, University of Pittsburgh), Gower (Forestry and Environmental Resources, NCSU), and Wojdak (Biology, Radford University) brought in M. Drew LaMar (Biology,

College of William and Mary), Robert Sheehy (Radford University), DorothyBelle Poli (Roanoke College), Carrie Diaz Eaton (Unity College), and Kristin Jenkins (Executive Director, BioQUEST Curriculum Consortium), to write the successful \$2.9 million award “Supporting Faculty in Quantitative Undergraduate Biology Education and Synthesis (QUBES).” <https://qubeshub.org/>

QUBES¹ was born out of a desire to address the nation’s growing need to better prepare undergraduate biologists with quantitative and computational skills. The grant was written to include the creation of faculty mentoring networks, infrastructure for disseminating resources for teaching quantitative biology, and more. QUBES now supports the mission of fostering a community of math and biology educators who share resources and methods for preparing students to use quantitative approaches to tackle real, complex, biological problems.² The virtual hub supports five major initiatives:

- QUBES Consortium: coordinating the efforts and resources of disparate communities invested in promoting quantitative biology education;
- QUBES Faculty Mentoring Networks: supporting faculty understanding and implementation of specific quantitative biology concepts and teaching approaches;
- QUBES Hub: increasing the visibility, utility, and adoption of existing quantitative biology materials and the capacity for peer educator interaction;
- QUBES Metrics: quantifying and tracking faculty contribution to quantitative biology education scholarship;
- Implementation Research: studying and disseminating the features of QUBES that increase implementation successes.

On QUBEShub.org, project leaders M. Drew LaMar, Sam Donovan, and Kristin Jenkins have worked to establish online learning communities that connect teachers with quantitative biology projects, resources, and expertise while also supporting implementation in the classroom. Much of the work involves thinking carefully about what structures

(social and technical) actually help faculty change their teaching.

The Challenges and Solutions

As QUBES began to grow, so did their need for support. When the Science Gateways Community Institute (SGCI) was funded by NSF in August of 2016 to provide a variety of services to the community of science gateway builders and users,³⁴⁵ the QUBES team was one of the first to request services.

Since their initial request to engage with one of SGCI's service areas, the QUBES team has now engaged with each service area offered by SGCI.

- Extended Developer Support: custom development support
- Incubator: Science Gateways Bootcamp and usability consulting
- Workforce Development: hosted an intern through the summer internship program
- Community Engagement and Exchange: attended and presented at Gateways 2017
- Scientific Software Collaborative: added QUBES to the Gateway Catalog

For the purposes of this case study, we will primarily focus on the engagements that the QUBES team had with Extended Developer Support, Incubator, and Workforce Development to illustrate the many ways that the team was able to improve their gateway.

Extended Developer Support

“As education experts, we have some strong notions about the types of faculty activities we want to support—but realizing those ideas in a gateway context was beyond our capacity. Working directly with programmers and development project manager through the EDS program was personalized, professional and extremely productive.”

One of QUBES' major initiatives is Faculty Mentoring Networks, which support faculty understanding and implementation of specific quantitative biology concepts and teaching approaches. The initiative was inspired by the QUBES team's belief that faculty need mechanisms to build up their professional identities as teaching scholars, and making their efforts more visible is a big part of achieving

this. The team pursued a publishing model using open educational resources that would make it easier for faculty to document and share the many ways that they customize existing teaching materials for their student audiences and teaching settings such as large lectures, seminars, online courses, lab, or field-based courses. Achieving this would require a more robust version-control system which the team modeled after [GIT](#), a free and open-source, distributed, version-control system that helps to coordinate and track collaborative contributions to a shared product and also allows users to take a version and “fork” it in a new direction by building on top of an existing code base.

This led to the idea to offer QUBES users the ability to “fork” publications. Most commonly, forks are used to either propose changes to someone else's publication or to use someone else's publication as a starting point for one's own idea. As their gateway is hosted on the open-source [HUBzero](#)®⁶ platform, the team knew that their offering was highly customizable and that this was possible to achieve, but what they didn't have was the technical know-how nor the time to dedicate to implementing the changes needed.

An additional benefit to the implementation of forking abilities would be that QUBES could better track how many times a resource has been forked, which has the potential to provide powerful metrics in their evaluation efforts that can be shared with key stakeholders and funding agencies.

The team submitted a request to SGCI's Extended Developer Support (EDS) service area. In doing so, they could receive up to a year of custom development support from EDS consultants. SGCI's Associate Director of EDS Marlon Pierce assigned the project to Shawn Rice, EDS Consultant and Application Programming Manager at Purdue University, who worked with the QUBES team to identify their objectives and thus the scope of the work that would need to be completed. Rice identified that the tasks and resources required to fulfill the objectives included programming tasks, programming expertise, and advice. The programming tasks would require access to and modification of the HUBzero CMS core code, with development centered on some of HUBzero's components and plugins.

Rice created a Work Plan that identified three deliverables that would result from QUBES' engagement with EDS:

- Development of the capability to “fork” a publication on the HUBzero CMS. When forked, the contents of a publication are cloned and copied into a new draft publication that may be extended, altered, and re-published. The original publication is left unaltered. When forking, the user is prompted to decide if the fork will become part of an existing project, new project, or be a standalone publication, and file and project setup

occurs as per the desired choice. Where possible, files and content are referenced or pointed to rather than copied in their entirety in order to mitigate potential issues such as dramatic increases in file system usage that could occur should a project that contains large files be copied numerous times.

- Making it so forked publications retain attribution based on the historical relationship to the original submission. The goal would be for the attribution on a published fork to be prominent and recognizable, and that it can be viewed and navigated in a way that any fork can be followed to its source or vice-versa.
- Adding the ability for an assigned license of a publication to indicate if it allows for derivations of the source materials, which will determine if a publication can be forked or not. Since submitters of publications choose the desired license, they would ultimately decide if they want to allow forking of their content or not.

Also identified in the Work Plan are milestones, which include estimated completion dates; resources for the client, which identifies EDS staff that will be working on the project; as well as a risk analysis that identifies risks that could cause complications in the successful fulfillment of milestones and/or deliverables by their expected completion dates.

“Having a stable and well-designed tool is essential as we engage faculty with new ways of thinking about their work; poor technical performance would totally undermine our efforts to change behavior.”

The first of the deliverables occurred in April 2017 and were monthly from then on. The final code was delivered to the QUBES production site in August 2017, with some minor adjustments and bug fixes delivered in September of 2017.

About the work completed for QUBES, Rice explained the importance of the Work Plan template, along with the invaluable advice provided by Marlon Pierce. He noted that the Work Plan helped to ensure that work was broken into feasible portions given the allotted time, providing both a guide to keep development from lagging and to keep development from expanding out of control (e.g., feature creep). Rice also noted that, for this particular EDS project,

the idea presented would seem to be fairly straightforward, especially in a world where people are increasingly familiar with technologies such as GIT where forking code is quite common. However, it presented some interesting challenges. “One of the challenges was in the arena of User Interface/Experience (UI/UX). The challenge arose in adding to an existing, well-established interface in a modular manner as the ability to ‘fork’ a publication was to be an optional feature that could be disabled. Before even writing any code, the clients and I worked through a number of interface ideas and adjustments over the course of a few weeks.” Rice continued by explaining that, thanks to the aforementioned Work Plan and careful consideration when writing it, these interface challenges were planned for and incorporated into the plan as the first milestone, allowing the project to continue apace. He reported that the feature was delivered on time and to what seemed like much eagerness for users to begin employing it and that, already, QUBES have begun expressing ideas on how to expand the feature set.

Commenting on the work completed by Rice, Donovan noted that the support from EDS allowed for a publishing environment that has the potential to change the culture of undergraduate quantitative biology education, adding that “having a stable and well-designed tool is essential as we engage faculty with new ways of thinking about their work; poor technical performance would totally undermine our efforts to change behavior.”

QUBES user William Morgan, Theron L. Peterson and Dorothy R. Peterson Professor of Biology at the College of Wooster, explained that the QUBES platform supports the

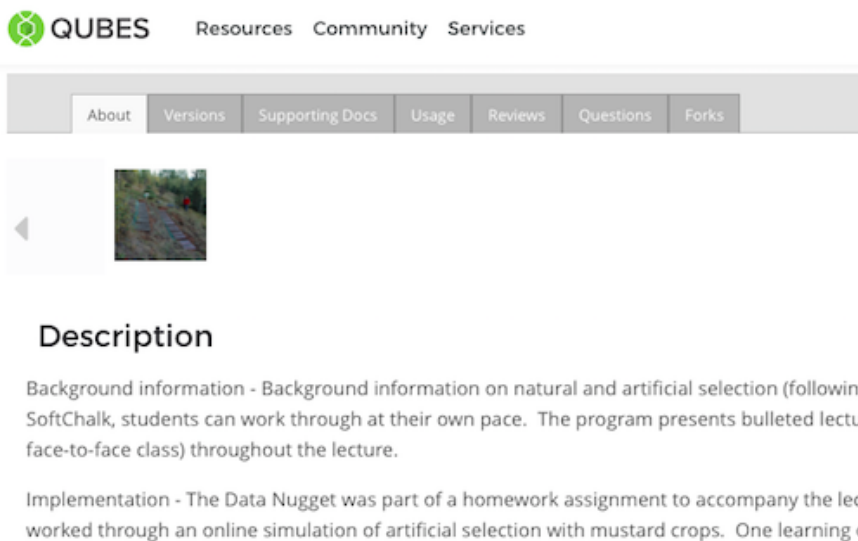


Figure 1. An example of how a teaching resource appears to users after site redesign and implementation of forking capabilities. The tabs include versions, supporting documents, usage, reviews, questions, and forks of teaching curricula.

[Network for Integrating Bioinformatics into Life Science Education's \(NIBLSE\) Learning Resource Collection](#)'s objective of providing supporting materials for Biology professors seeking to integrate bioinformatics into their classes. While most of their current processes use the Versions feature of the QUBES platform, Morgan looks forward to using the new forking feature, saying that "the forks feature will allow us to post and link upcoming adaptations of existing resources that have been customized for specific or novel purposes."

Another user, Kristine Grayson, Assistant Professor of Biology at the University of Richmond, is part of the [Data Incubator Group](#) on QUBES and added that the forking feature addresses challenges "by providing a public forum for disseminating adapted resources and a publications system with digital object identifiers for this work that is citable and searchable. This capacity has closed the loop of the open educational resources life cycle and provided a venue for a multitude of projects to expand their reach."

For other gateways using the HUBzero platform, the specific code that was written for QUBES could potentially be integrated if the desired feature is to increase the speed of publication by providing an existing body of work and/or data to iterate from.

Incubator: Science Gateways Bootcamp and Usability Consulting

Science Gateways Bootcamp

What started as one engagement with SGCI's EDS service area led to the team realizing that they could benefit from the full array of services offered. When SGCI announced the inaugural session of Science Gateways Bootcamp, the team saw it as an opportunity to develop QUBES while also working on its sustainability in the future. Three members of the QUBES team, Sam Donovan, Kristin Jenkins, and M. Drew LaMar, attended the Bootcamp in Indianapolis, Indiana, in April 2017.

SGCI's Science Gateways Bootcamp is a one-week intensive workshop that offers participants an immersive environment to further develop and scale their work. During the Bootcamp, participants engage in hands-on activities designed by a team of workshop leaders who are experienced entrepreneurs, researchers, and trainers, and who know how to help project leaders bridge the gap between funded projects and creating sustainable services and businesses. Participants work throughout the week to articulate the value of their work to key stakeholders and to create a strong development, operations, and sustainability plan.

An additional benefit for participants of the Bootcamp is that they work closely with one another and thus have the opportunity to network and establish relationships with other leaders of gateways. It's this opportunity to interact with others who are doing similar work that can open participants' eyes to the fact that the challenges they face are similar to those faced by others who are developing digital offerings.

During the Bootcamp, the QUBES team was exposed to a wide range of topics taught by experts. Topics included in the Bootcamp are as follows:

- Core business strategy skills as they apply to leading an online digital presence, including
 - Understanding stakeholder and user needs
 - Business, operations, finance, and resource planning
 - Understanding audience and meeting their needs
 - User engagement and marketing basics
- Technology best practices
 - Principles of cybersecurity
 - Software architecture
 - Development practices and tools that ensure implementation of strong software engineering methods
 - Usability and user experience fundamentals
- Long-term sustainability strategies
 - Alternative funding models
 - Case studies of successful gateway efforts
 - Licensing choices and their impact on sustainability
 - Planning for and measuring impact

At the end of the workshop, participants bring together all the materials they've developed during the week as a "pitch deck" of their sustainability strategy and the key action steps they need to take in order to attain their goals. The final day of the workshop is spent presenting their pitch decks and receiving feedback from instructors and peers.

"I don't want to say that we were naive about the breadth of challenges involved in building and managing a growing education gateway, but we certainly hadn't thought through everything. The Bootcamp gave us the kind of overview and practical advice that helped us decide how to allocate our resources and where we need to seek additional expertise."

The QUBES team left the Bootcamp with renewed energy and enthusiasm and with a clear vision of their next steps on their path to sustainability. Donovan noted that, prior to attending the Bootcamp, the team hadn't thought through all the challenges involved in building and managing a growing education gateway and that "the Bootcamp gave us the kind of overview and practical advice that helped us decide how to allocate our resources and where we need to seek additional expertise."

An added benefit of attending the Bootcamp was that, along with being exposed to new concepts and ideas, participants also learned more about the spectrum of resources available from the SGCI. The usability module of the Bootcamp made an impression on the QUBES team, and when they learned that usability consulting was available, they submitted a request to receive that support before they even left the Bootcamp.

Usability Consulting

Once a request for usability support has been submitted to SGCI, the project team is paired with one or two master's level students who are concentrating on usability and user experience design. In the first year of the intern program, students were based at the University of Michigan School of Information (UMSI) and supervised by paper co-authors Katherine Lawrence and Nayiri Mullinix. After the first year, SGCI moved the usability intern program to Purdue University under the supervision of Paul Parsons, Assistant Professor in the Department of Computer Graphics Technology. Since the request for services made by QUBES was made prior to this change they received support from two UMSI students, Purva Sane and Sue Gyuong Kim.

The consulting process kicked off with a meeting to discuss the team's goals for requesting usability help. The QUBES team had an opportunity to express their concerns about the website and to share with the interns how they hoped to improve the gateway. This included three main requests:

- Receiving general guidance for a website redesign to improve usability
- Improving their user interface to allow researchers to find biology and mathematics resources easily and more conveniently
- Designing the website to better promote and deliver QUBES features and functions to its new and existing users

Taking into consideration their requests, Sane and Kim devised a plan that included:

- Evaluating the usability of the website overall
- Comparing user interface designs with similar features offered by competitors

- Benchmarking best practices of user interface design
- Providing and testing new designs through an iterative user experience (UX) design process.

The interns used some popular usability methods, including heuristic evaluation, competitive analysis, and usability testing, in order to reveal problems and then to make appropriate recommendations.

Heuristic evaluation was used to inspect usability problems in the QUBES user interface based on usability principles outlined in [Jakob Nielsen's heuristics](#).⁷ These principles, which are intended to be viewed as broad rules of thumb and not specific usability guidelines, exposed some basic usability concerns on the QUBES website in four broad categories: visual design, navigation, consistency, and clarity. Along with their findings, Sane and Kim also provided recommendations for improvement.

Visual Design

- The main page was causing a visual overload due to red-colored hyperlinks, background patterns for a pop-up announcement, and poorly organized layouts for text. It was also revealed that it was difficult for new users to find out what it is that QUBES does on the homepage. *Recommendation:* Keep the main page simple and concise with clean layouts and with minimal use of colors to emphasize important items.
- Buttons and input fields on the website were not prominent enough due to being too small or lacking in contrast or both. *Recommendation:* Visibility of design elements such as buttons and navigation menus should be increased with a better use of color contrast and/or increased size.

Navigation

- The menu structure of the website and breadcrumbs (a navigational aid to help keep track of locations within the website, usually found near the top of the webpage) did not match, some of the links were broken and, at times, the same content was located in more than one section of the website. *Recommendation:* Remove or fix broken links and provide breadcrumbs that properly match the navigation structure.
- Users were finding it difficult to browse all the resources under the Resources menu due to the number of pages they had to visit before arriving at the "Browse All Resources" page. In addition, the link to the page was inconspicuous whereas the explanations of the Resources menu was more prominent. *Recommendation:* Provide efficient design and page structure for the Resources page.

Consistency

- Different styles and/or labels were used for the same items, such as buttons, links, and menu items.
Recommendation: Use clear and consistent labels for menu items and buttons.

Clarity

- Some labels for menu items and buttons were ambiguous.
Recommendation: Keep styling of similar items clear.

A **competitive analysis** was done to identify projects offering similar services and to evaluate similar features on their websites to determine both strengths and weaknesses on the QUBES website. Analyzing competitors can also be helpful since industry standards and best practices regarding usability can be revealed. By providing examples of websites that are working to convey a similar message or function, Sane and Kim were able to provide examples where similar websites had a clear website identity, provided an easy-to-use platform, and had a well-organized navigation flow, and they followed-up with specific recommendations for QUBES. These included:

Website Identity

- Explain what QUBES does concisely.
- Maintain a clear typeface hierarchy with only one or two typefaces.
- Have a simplified layout on landing pages to direct users' attention to the most relevant information on the page.
- Keep color scheme in line with the website's brand or identity.

Ease of Use

- Provide prominent design elements for essential functions.
- Allow users to narrow down the list of resources by using filters or categories instead of typing a search term.

Navigation Flow

- Menu structure should be simple and allow navigation to all essential pages.
- Provide meaningful breadcrumbs to orient users to their location on the website.
- Use the footer for placing important site-wide links.

The final step was for the interns to plan and conduct **user testing** in order to understand how users interact with the current version of the website. With a predetermined set of questions and tasks, user testing was conducted with three

participants who had used the website for more than one year. The testing began by asking the users questions about their familiarity with the QUBES website and their motivations for using it. Each participant was asked to perform the tasks on the existing website while thinking aloud and when the tasks were completed, the participant was asked for a general impression of the website as well as any other comments or suggestions about the user experience.

Based on this first round of testing, Sane and Kim shared their findings and their corresponding recommendations:

- Consider changing the landing page after users log in to the QUBES website. At that time, users who logged in were taken to their dashboard, where they could access their groups and projects.
Recommendation: Consider redirecting users to the page where they logged in so that they could continue navigating the main QUBES website.
- On the subpages in the Resources section, the "Getting Started" link was the first thing that most users noticed. Since "Getting Started" was a generic page which provided information about the QUBES website and wasn't specifically related to resources, it was potentially distracting users from their goal of finding resources.
Recommendation: Implement a prominent search bar or "Browse Resources" link that would grab users' attention and make searching more efficient.
- The filter menu was located on the right side of the page, which goes against users' experience with other sites and, thus, caused them to not notice the option to filter.
Recommendation: Move the filter menu to the left side to better align with user expectations.
- The main menu structure and the submenu found on the left side of the groups/projects page were too complicated.
Recommendation: Reduce the complexity of the main menu structure and left submenu within groups/projects in order to reduce the time users have to spend figuring out where important functionalities are located and to increase the quality of the user experience.

With the findings from the heuristic evaluation, competitive analysis, and user testing, Sane and Kim were able to design **wireframes**, or design mockups, using Axure (a wireframing, rapid-prototyping, documentation and specification software tool). They built an interactive prototype with a new design that was based on their analysis and findings. They were then able to test the prototype with another round of user testing to find usability problems in the

prototype and to fix them by providing recommendations for improvement.

The wireframes were used in two ways: to communicate design ideas to the QUBES team that could be easily revised based on their feedback, and to test the usefulness and ease of use of the new design prior to implementation.

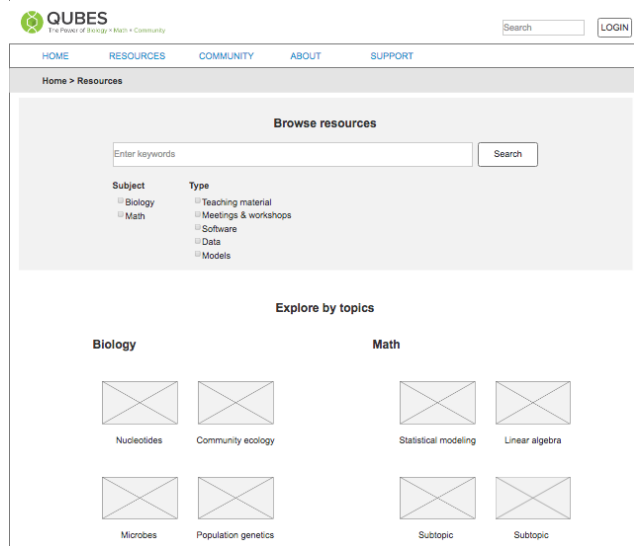


Figure 2. A wireframe, or design mockup, that Sane and Kim created using Axure and then used to help identify problems while conducting user testing.

The wireframes were used for the second round of user testing, which Sane was able to conduct face-to-face during the “Making Meaning through Modeling” QUBES workshop that took place at Michigan State University in July 2017. The six participants were selected carefully to include both less experienced users who had used the website for less than two months and also veteran users who had used it for more than a year.

The testing revealed four main problem areas, for which Sane provided recommendations:

- Searchability is important for users of QUBES and having an effective search engine that provides accurate and quick results would better serve user needs. It was revealed that some users prefer to extensively apply filters before searching so that they get limited results, while others prefer to search first and filter later.
Recommendation: Add a simple search bar with an “Advanced Search” option which contains all the filters. This would support both types of user behavior.
- Users often get confused between the different functions that QUBES offers and are not sure which one is the appropriate solution for their needs.

Recommendation: Simplify the layers of complexity within QUBES. If a new feature is added, such as a proposed “portals” function, the website architecture should be restructured to remove or simplify some of the other features.

- Categorization of resources within the “Math” and “Biology” sections could be overwhelming to users.
Recommendation: Consider grouping the resources into topics rather than trying to assign the topics to Math or Biology. Since there could be overlap with resources belonging to multiple categories, it could prove difficult to tag a resource as Math or just Biology
- Users expressed a need for some flexibility with respect to how search results are viewed and sorted.
Recommendation: It might be useful for some users to be able to have multiple viewing options for search results, such as an option to “view as a grid” or an option to “view as a list,” or to have the ability to change the number of entries viewed per page and additional abilities to sort by date, popularity, or alphabetical order.

The QUBES team found this usability support to be integral to their overall vision of building community. For them, one big goal is to make sure that people feel welcome, included, and empowered by working with what QUBES offers. It’s for this reason that the team felt the user experience on their website was a critical component of their success.

After extensive discussion with members of the QUBES leadership team (Hayley Orndorf, Sam Donovan, and M. Drew LaMar) and QUBES web designer Jennifer Kwan, the first version of the website redesign launched in March 2018, with some of the recommendations made by Sane and Kim integrated. Some things they were able to implement on their own, but the team also worked with HUBzero to actively address many of the issues that were revealed as a result of the heuristic evaluation, competitive analysis, and user testing, including:

- Clarifying QUBES’ mission and vision and making sure users understand what’s available to them. This included redesigning the site map and the main pages of the website. A big part of the redesign was to simplify the menu items.
- Improving navigation throughout the website in a variety of ways. For example, the footer of the website now includes the complete site map as well as direct links to social media and newsletter signup.
- Improving contrast, readability, and suggested actions, which was achieved by making sure links were no longer red, changing the contrast of text and background throughout the site, and increasing font size.

The QUBES team expects that the usability improvements will be an ongoing process. Some plans for the future include adding user communities to the side dashboard and continuing to address readability throughout the site.

Workforce Development

“Jacob’s internship gave me the opportunity to expand my mentoring into software development, which is one of my passions. I had very little experience specifically in web development, so it was extremely helpful to have Jacob as a colleague to talk to and learn from. If it wasn’t for the foundation laid by Jacob over the summer of 2017, I’m convinced it would have taken us longer to achieve what we have.”

SGCI’s Workforce Development service area offers undergraduate and graduate students, as well as young professionals, access to mentoring, career development, and hands-on experiences such as workshops and internships, providing the opportunities needed to pursue a career in building or using science gateways. For the summer of 2017, M. Drew LaMar from the QUBES team worked with Workforce Development to support an intern working with him at the College of William and Mary.

Jacob Harless had just completed his junior year studying Computer Science at the College of William and Mary when he joined QUBES as an intern. He spent the summer working with LaMar on improving the QUBES platform by adding components and plugins to the existing HUBzero code. Specifically, Harless worked on a component that stores and displays [QUBES Partner Information](#) throughout the site. Most of his work was backend development in PHP, but also included front-end work with HTML, CSS, and Javascript.

The work Harless completed made an important contribution to QUBES’ business model since they offer services to their Partners including dynamic website

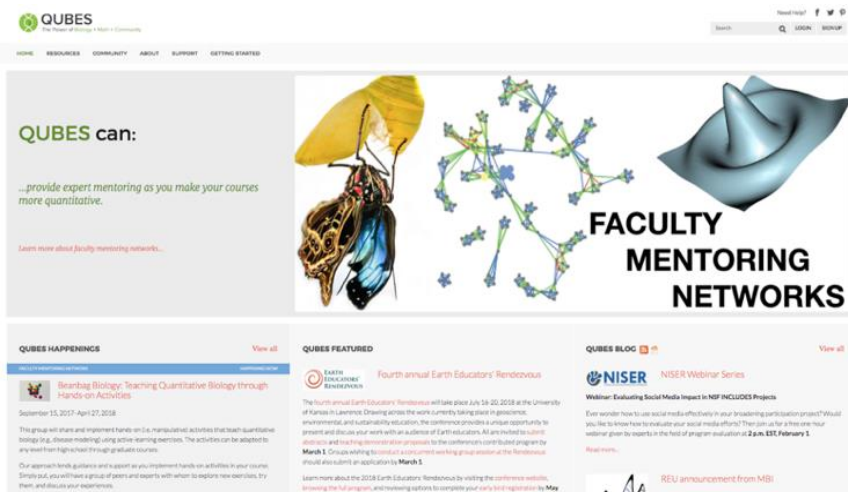


Figure 3. How the QUBES homepage looked prior to implementing recommendations made by SGCI usability consultants.

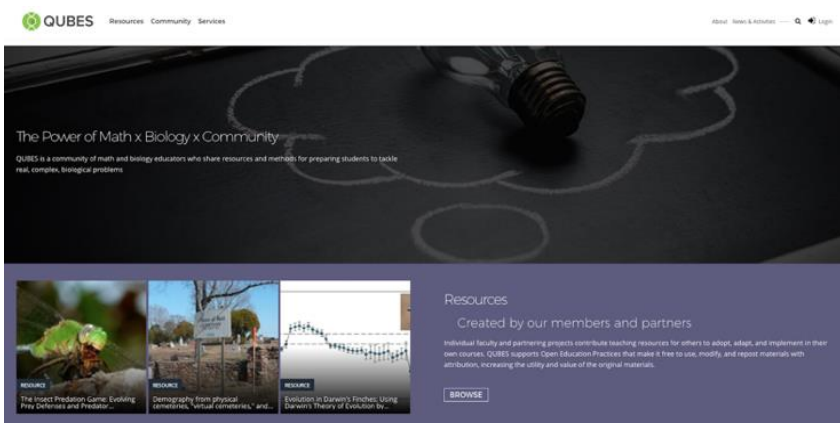


Figure 4. How the QUBES homepage looks after usability recommendations were implemented. There are fewer menu items, the red links have been removed, font size has been increased, and social media links have been moved to the footer (not visible in this figure).

hosting, workshop support, dissemination of events and products, and a customized open education resource publishing platform.

Prior to his internship, Harless hadn’t had many experiences with web development since it wasn’t something he had learned as part of his studies in Computer Science. His feeling was that this was an important experience which contributed to him becoming a well-rounded candidate for when he graduates and starts job hunting.

LaMar says that Jacob’s contributions helped not just the QUBES project, but him personally, too. “An important part of my job at William and Mary is mentoring students, usually in quantitative biology,” said LaMar. “Jacob’s internship gave me the opportunity to expand my mentoring into software development, which is one of my passions. I had very little experience specifically in web development, so it was

extremely helpful to have Jacob as a colleague to talk to and learn from. If it wasn't for the foundation laid by Jacob over the summer of 2017, I'm convinced it would have taken us longer to achieve what we have."

During the internship, Harless was also able to attend PEARC17, where he had the opportunity to experience the diverse gathering of scientists, researchers, system administrators, and more, who come together to share experiences and solve problems. As his work for the summer consisted mainly of reading code from the HUBzero platform, it proved to be a powerful experience to see, in person, the community that surrounds gateway developers and enthusiasts who are interested in solving similar problems.

A notable outcome of Harless's internship is that he could submit the plugin and component he developed to the HUBzero code base, which is open source, potentially making them available to others who use the HUBzero platform. In other words, it's possible that the work he completed as an SGCI intern working on the QUBES project could help another gateway in the future.

Other Engagements with SGCI

While this case study focuses on QUBES' engagement with three of SGCI's service areas, two other service areas have offered valuable experiences or resources to the QUBES team. SGCI's Community Engagement & Exchange area brings together community members through events including an annual conference and monthly webinars. LaMar attended the inaugural Gateways 2016 conference near the time that he began his work with EDS. The following year, both LaMar and his intern Harless attended Gateways 2017; LaMar presented a paper and participated on a panel, and together they presented a poster.

In addition, QUBES is now listed in SGCI's Gateway Catalog, developed by the Scientific Software Collaborative area of the Institute. The Catalog serves as a way for users and developers to identify gateways of interest to their work. For example, using the Catalog, an instructor might find QUBES while searching for a teaching resource, whereas a developer might find QUBES as one of several examples of gateways using HUBzero. The Catalog offers many ways to search and filter gateways and is adding capabilities to list software components for gateways as well, allowing discovery and connections across the gateway community and the domains it supports.

Future Plans

The range of services offered by the SGCI was carefully designed in order to benefit the science gateway community

in a variety of ways, and that QUBES was able to take advantage of the full array provides a strong illustration of how other gateways can benefit, too. Having access to these resources, and at little or no cost to the client, has made a significant impact on QUBES and has helped the team achieve its goals. Donovan explains, "As education experts, we have some strong opinions about the types of faculty activities we want to support—but realizing those ideas in a gateway context was beyond our capacity. Working directly with programmers and development project managers through the EDS program was personalized, professional and extremely productive."

"SGCI is a community of like-minded colleagues interested in the same things we are, which is maximizing the impact and minimizing the pains of utilizing cyberinfrastructure in faculty's research and teaching."

As the QUBES team looks to the future, they plan to continue to engage with SGCI in a variety of ways. As LaMar explains, they feel that they are a part of this community now and will continue to greatly benefit from the resources and opportunities offered by SGCI. "SGCI's role in providing UX support has been a huge benefit to us. It is important to mention, though, that it is more than just the initial UX support. We feel supported even beyond the initial UX study—SGCI is a community of like-minded colleagues interested in the same things we are, which is maximizing the impact and minimizing the pains of utilizing cyberinfrastructure in faculty's research and teaching."

They're not ruling out the possibility of requesting further services, either. Now that the new version of their website has launched, for example, they are already considering requesting further help from our user-experience interns in another round of user-testing that could reveal how the changes that were made impact users and to determine if further improvements are needed.

Future plans for QUBES include, for example, developing infrastructure for the publication component of scholarly teaching and emphasizing the importance of publicly sharing work. In doing so, QUBES is shifting to providing information, infrastructure, and training to promote scholarly teaching and open educational resources. This reimagining of their work would move the QUBES vision beyond a resource center to a research center and, thus, allow them to go further as they work to address the challenges in improving quantitative biology education. As QUBES evolves, the team knows that they can come to SGCI for the support, services, and resources that could enable their growth and, as a result, the growth of their users.

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