Building a Web-based Environment to Support Sponsored Research and University-wide Collaborations

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***Abstract*—At the federal level, an organized partnership exists to serve military families, an association composed of the Department of Defense (DoD), the Department of Agriculture (USDA), and colleges and universities throughout the United States of America. Through this partnership, cooperative agreements are executed to support the needs of service members and their families. One such cooperative agreement between DoD, USDA, and Auburn University is Military REACH. This project aims to bridge the gap between military family research and practice by mobilizing peer-reviewed family science research into practical applications for military families and those who work on behalf of military families. At Auburn University, this project is an interdisciplinary collaboration between the academic libraries, the Department of Computer Science, and the Department of Human Development and Family Science. This paper aims to represent the Military REACH website and the new searching functionalities added to the project to increase users' numbers using Google Analytics results.**

Keywords–Military Families; Applications; Resources.

I. INTRODUCTION

For the past three years, the Auburn University Libraries and Computer Science Department have supported the University's research enterprise in a new way: by adopting a new collaborative model and serving as a high-level Information Technology (IT) and data-management consultants to faculty researchers who are pursuing external funding. A practical example of this model in action is the Military REACH project at Auburn University funded by the Departments of Agriculture and Defense (USDA/NIFA Award No. 2017-48710-27339; PI, Dr. Mallory Lucier-Greer). The purpose of Military REACH is to make research accessible to policy makers, helping professionals, and military families in a manner that is inviting, easily understood, and meaningful for their everyday context [1]. Our team, housed at Auburn University, works to critically evaluate empirical research related to military families and translate it into useful tools. These tools are actively disseminated to policy makers and military helping professionals to inform their decisions and practices as they work to support and enhance the lives of service members and their families. Specifically, the objective of this project is to provide high- quality resources to the Department of Defense (DoD) in the form of research and professional development tools across the spectrum of family support, resilience, and readiness. This work is primarily supported by the DoD's Office of Military Community and Family Policy. The purpose of this project is achieved through three primary deliverables, including:

- Provide timely, high-quality research reports at the request of DoD.
- Re-engineer, grow, and promote an online library of current research and its implications related to the well-being of military families.
- Design and market professional development opportunities, tools, and resources for youth development professionals.

The Military REACH Project is now in its fourth year and seems likely to continue; indeed, it has highlighted the library's value as an IT partner and led to research partnerships and collaborative funding proposals with other units on campus. This paper describes the related functions that are designed and implemented for each operator. The rest of the paper is organized as follows. In Section II, we cover some background about the project. Section III introduces our efforts to serve military families and covers the design and implementation of the website. Section IV demonstrates evaluation methods

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using Google Analytics. Section V provides evaluation results of the website. Section VI concludes the project along with suggestions for future enhancements.

II. Related Work

Military REACH started by evaluating existing research in the context of Research Infrastructures (RI) and Digital Libraries (DL). Recent reviews of digital preservation [2] and projects that promote research and awareness in the areas of digital preservation include CEDARS [3].

Two decades of research have worked to improve awareness of the digital preservation challenge and encouraged some organizations to improve the longevity of their digital resources. One of the most significant streams of research has been within cultural institutions, sometimes in collaboration with industry partners, to develop solutions to operational problems in these institutions [4]. National, regional, and University archives and libraries in Australia, Canada, Belgium, Denmark France, Germany, the Netherlands, New Zealand, Sweden, Switzerland, the U.K., the U.S., and elsewhere have investigated the implementation of institutional repositories, preservation, and strategies for Web archiving.

III. Collaborative Efforts to Serve Military Families

Working closely with the Military REACH team in the College of Human Sciences, the library's IT department contributed to the original funding proposal and has guided network architecture, Web development, IT tools and solutions, sustainability, data management, accessibility, usage statistics, and automated methods for identifying recently published research.

A. Design and Implementation

The REACH Web application has an architecture that can be implemented into three layers, as shown in Figure 1.

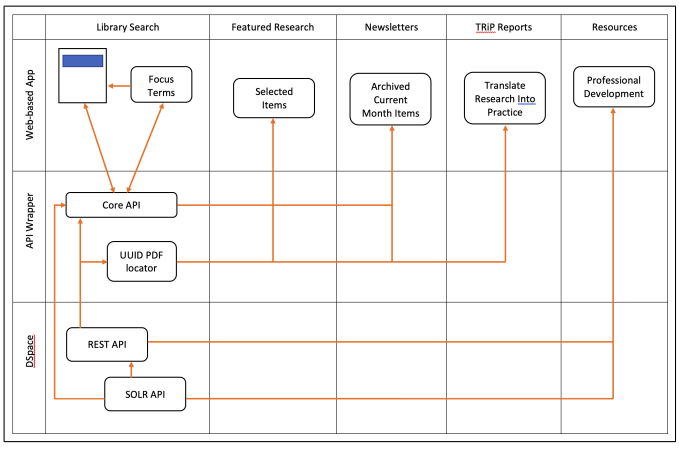

Figure 1. REACH System Architecture.

- Web-based app: This layer is the front-end of the application, where we mainly use Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript in Java Server Pages (JSP). Also, the Cascade Content Management System (CMS) that we use to manage the JSP falls under this layer.
- Application Programming Interface (API) Wrapper: This layer is the back-end layer, where we use JAVA to write classes and methods that handle various functionalities of the website such as search, filter, sort, and so forth.
- DSpace: DSpace is an open-source repository software package mostly used to create open access repositories for the scholarly and published digital content. DSpace is the central database of the application. All Military REACH related research articles are stored in this layer. DSpace uses Apache SOLR based search for metadata and full-text contents, all of which are stored in a relational database and supports the use of PostgreSQL. Also, DSpace is used to manage and preserve all the formats of digital content (PDF, Word, JPEG, MPEG, TIFF files). Likewise, it also allows for a group based access to control the setting for level based permission to individual files.

1) Introduction to the Cascade Content Management Systems: To make the website easy to update, we are also making use of CMS. Cascade CMS is used in the Web application to manage site content, allowing multiple contributors to create, edit, and publish. Content created in a Cascade CMS is stored in Cascade as an XML file and displayed in a presentation layer based on a set of templates. Programming languages such as Extensible Stylesheet Language Transformations (XSLT), and Velocity [5] are used to transform the Extensible Markup Language (XML) file into HTML/JSP pages.

The typical features of a CMS can be as follows:

- Content creation (allows users to easily create and format content)
- Content storage (stores content in one place, in a consistent fashion)
- Workflow management (assigns privileges and responsibilities based on roles such as authors, editors and admins), and
- Publishing (organizes and pushes content live)

2) Cascade Content Management Systems Benefits: What makes Cascade extremely beneficial to a Web application, such as the Military REACH website, is the ease of updating it. Since it is an interface that can be easily used by non-programmers, once it is set up, people without a background in programming can use it to make substantial changes to the website. The What You See Is What You Get (WYSIWYG) editors included in the platform allow users to enter text and upload images even while they lack basic knowledge of HTML or CSS (languages that are vital for any Web application development).

The other advantage of having CMS in our website development process is its collaborative nature. Multiple users can log on and contribute, schedule or edit content to be published. Since the interface is browser-based, Cascade can, therefore, be accessed from anywhere by any number of users.

Similarly, Cascade CMS has an efficient, reliable way of sending frequent alerts to the users and site administrators of pages that have not been updated for a certain duration of time. The use of in-built features such as the daily content report, task manager, and content review dates helps an organization

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to stay fresh and take necessary steps to keep its users up-to-date.

Lastly, Cascade has a community of over 100,000 active users that are frequently using the platform and are readily available to voice their experiences with using features and capabilities of Cascade.

3) Use of Cascade Content Management System on Military REACH:

- The Teams page and Resources page of the website are entirely made in the Cascade CMS. These are the pages in the website that can be easily updated by even the non-technical team members in the organization.
- Other pages, such as the Home page, the Families page, the Contact Us page, and so on, are more hybrid, where all of the texts displayed in the pages can be edited from Cascade. Other major functionalities within the pages are, however, handled in the back-end by the developers.
- Therefore, having Cascade only pages and hybrid pages simultaneously gives a lot of flexibility for both the technical and non-technical team members involved in the organization.

IV. Evaluation Methods

A. Google Analytics

Military REACH has been using Google Analytics to access the user data since last year (March 1, 2019 - July 31, 2020). Google Analytics data do not include any personally identifiable information. They are presented in the aggregate data, making it a practical tool used in research settings without ethical concerns [6][7]. The Web development team installed Google Analytics by adding a tracking tag for Military REACH. The tracking tags are a combination of JavaScript and computer programming language used to develop the website. The tracking tag code allows contributing different forms of data related to the users' behavior on the website as soon as they visit the Military REACH website. The data can proceed from diverse avenues. For example, the URL of the page and the device used to access the site. Tracking code collects more data on the nature of the visit, such as the contents viewed, length of the session, average time on each page, location, etc. This information is in a real-time, interactive dashboard format that can be viewed by logging in to Google Analytics.

B. User Engagement

This project focuses on several indicators from Google Analytics to evaluate the level of engagement. These indicators contain the number of returning users (n), bounce rate, number of pages accessed per session (n), mean session, and time spent on each page (minutes, seconds).

The number of returning users mentions the number of sessions visited through the same client IP. A high number of returning users indicates a strong level of engagement with the Web-based platform [6][8].

The bounce rate is a percentage of single-page sessions in which there was no interaction with the page. A high bounce rate means minimal interaction with the page; however, it could also mean that users exit the page after finding what they were looking for right away. A low bounce rate can refer to a high overall engagement, especially for a multi-component platform like Military REACH. For example, there are not many available resources that would provide mental health support on the platform's home page. Therefore, users will often need to interact with various searching tools and Web pages to access the required information.

The number of pages per session indicates the number of Web pages that the user viewed in a single session. The mean session duration (minutes, seconds) means the mean duration of the time users spend on the website. Using these indicators to increase user engagement can be challenging. There are different interpretations. For example, many pages per session could occur from a high level of engagement, while it could also cause a superficial exploration of several pages. Besides, a long session duration can result from increased attention, but it could also be because the user keeps the Web page open while engaging in the other irrelevant activities.

C. Platform Improvement

Military REACH considers some other indicators from Google Analytics to inform the improvement of the platform. These indicators include page views, mean duration of visit, and bounce rate when accessing self-help tools (e.g., Family Focus page, TRIP reports page). Besides, the most visited pages were observed in terms of their overall average time spent on the page to understand which tools or pages were most beneficial or viewed.

The entrance rate illustrates a proportion of sessions starting from a given page. In comparison, the exit rate results from a ratio of sessions ending from a given page. The information regarding the entrance rate may explain which Web page serves as the first impression for the users. The exit rate may indicate when users felt disengaged or had adequate data needed for the session. Google Analytics provides information on the type of devices users are using to access the website. Such data can allow us to consider if implementing a mobile app for Military REACH would be practical or not. The three primary devices of interest to the current investigation are desktops, tablets, and mobile phones (counted here as mobile devices).

D. Marketing Strategy

Military REACH aims to reach as many users as possible. Therefore, we used Google Analytics to inform our marketing strategy. The research team has been reaching out to various military-connected organizations, especially around the United States. Twitter, Facebook, and LinkedIn accounts were also created to distribute awareness about the platform. To improve the marketing strategy, the ways used to access the website were analyzed. The methods include a direct link (i.e., typing the Web URL directly into a browser); organic search (i.e., entry through a search engine); and referrals via another website via social media via email. Understanding which ways are most accessible for users can help to improve the marketing strategy. Military REACH also uses the locations of users from different countries around the world.

V. Evaluation Results

Military REACH started using Google Analytics since March 2019. The first version of the website was based on a single page application (March 2019 - November 2019). However, to better access our users' data, we switched to

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multiple page application using Java Server Pages (JSP) and Servlets (November 2019 - present). The following are the results from Google Analytics, which show the positive impact of this change in user engagement and platform functionalities to serve military families better.

A. User Engagement

The last year of operation for the Military REACH platform saw 3,131 users from November 2, 2019 – June 11, 2020, and a total of 1806 users from March 1, 2019 - November 2, 2019 (Shown in Figures 2 and 3).

On average, users visited 5.22 pages per session from November 2, 2019 – June 11, 2020, and 13.31 pages from March 1, 2019 - November 2, 2019.

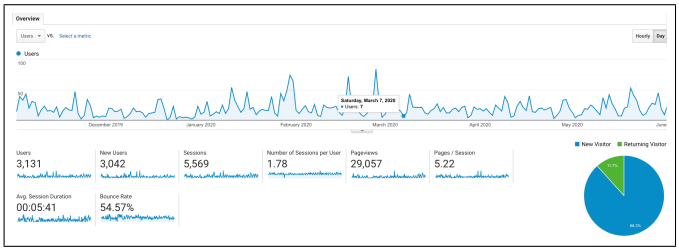

Figure 2. REACH overview presented in Google Analytics (Nov 2, 2019 - June 11, 2020).

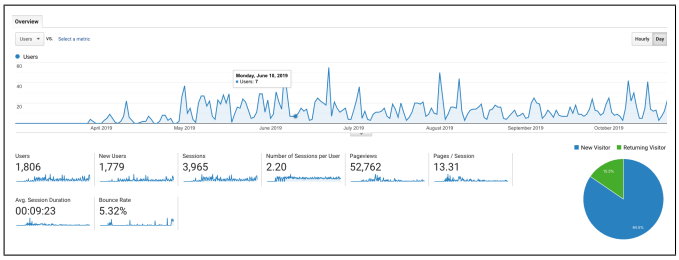

Figure 3. REACH overview presented in Google Analytics (March 1, 2019 - November 2, 2019).

The results show that user engagement is increasing because of social media marketing, conferences, and overall better efficiency and effectiveness of the website.

B. Platform Improvement

Visits to the Military REACH Home Page comprised 15.62% (4244/27,111) of the total pageviews from November 2, 2020, to June 11, 2020, with an average duration spent of 1 minute and 20 seconds.

Table 1 presents details of the top ten most viewed pages. In March 2019 to Nov 2019, the Military REACH home page, which acts as the landing page, accounted for 51.41% (7782/15,136) of all entries when the website was still a single page application using Angular and Typescript. However, after transforming to multiple page applications, users can access the resources they are looking for, using shared links on our social media or email. A list of devices used by Military REACH users to access the site is presented in Table 2, indicating that the platform was accessed mostly via desktops (2112/3130, 67.43%). Furthermore, sessions completed via desktops had a higher average session duration than those completed via other devices.

TABLE I. REACH MOST VIEWED PAGES.

Page		Pageviews	Unique Pageviews	Avg. Time on Page
	Change	79.54%	208.24%	82.39%
	Total Nov 2, 2019 - Jun 11, 2020	27,111	18,800	0:01:20
	Total Jul 15, 2019 - Nov 2, 2019	15,136	6,118	0:00:44
1	/homepage			
	Nov 2, 2019 - Jun 11, 2020	4,244 (15.62%)	3,046 (16.15%)	0:01:09
	Jul 15, 2019 - Nov 2, 2019	7,782 (51.41%)	2,393 (39.11%)	0:00:25
	% Change	-45.46%	27.29%	171.80%
2	/Redirect			
	Nov 2, 2019 - Jun 11, 2020	1,376 (5.06%)	634 (3.36%)	0:01:59
	Jul 15, 2019 - Nov 2, 2019	135 (0.89%)	51 (0.83%)	0:00:46
	% Change	919.26%	1143.14%	158.33%
3	/reachlibrary.jsp			
	Nov 2, 2019 - Jun 11, 2020	1,127 (4.15%)	635 (3.37%)	0:00:30
	Jul 15, 2019 - Nov 2, 2019	93 (0.61%)	49 (0.80%)	0:00:38
	% Change	1111.83%	1195.92%	-22.78%
4	/Updates			
	Nov 2, 2019 - Jun 11, 2020	862 (3.17%)	591 (3.13%)	0:02:13
	Jul 15, 2019 - Nov 2, 2019	127 (0.84%)	58 (0.95%)	0:01:18
	% Change	578.74%	918.97%	69.97%

TABLE II. DEVICES USED TO ACCESS MILITARY REACH

Devide Category	Users	New Users
Change	176.01%	182.10%
Total Nov 2, 2019 - Jun 11, 2020	3,130	3,041
Total Jul 15, 2019 - Nov 2, 2019	1,134	1,078
desktop		
Nov 2, 2019 - Jun 11, 2020	2,112 (67.43%)	2,040 (67.08%)
Jul 15, 2019 - Nov 2, 2019	779 (68.57%)	737 (68.37%)
% Change	171.12%	176.80%
mobile		
Nov 2, 2019 - Jun 11, 2020	975 (31.13%)	956 (31.44%)
Jul 15, 2019 - Nov 2, 2019	332 (29.23%)	318 (29.50%)
% Change	193.67%	200.63%
tablet		
Nov 2, 2019 - Jun 11, 2020	45 (1.44%)	45 (1.48%)
Jul 15, 2019 - Nov 2, 2019	25 (2.20%)	23 (2.13%)
% Change	80.00%	95.65%

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C. Marketing Strategy

Approximately 89.58% (2804/3129) of the users accessed the website from the United States. Table 3 shows that the users accessed the platform from around the world (Figure 4).

Google Analytics was a helpful tool to process the evaluation of the open-access, Web-based Military REACH platform.

The process evaluation provided information about the ways to keep users engaged, marketing strategies, and the aspects of the platform that required improvement.

TABLE III. LOCATIONS OF USERS FROM GOOGLE ANALYTICS.

	Acquisition		
	Users	New Users	Sessions
Change	175.93%	182.00%	169.62%
Total Nov 2, 2019 - Jun 11, 2020	3,129	3,040	5,565
Total Jul 15, 2019 - Nov 2, 2019	1,134	1,078	2,064
United States			
Nov 2, 2019 - Jun 11, 2020	2,804 (89.58%)	2,717 (89.38%)	5,193 (93.32%)
Jul 15, 2019 - Nov 2, 2019	1,050 (92.51%)	995 (92.30%)	1,969 (95.40%)
% Change	167.05%	173.07%	163.74%
Canada			
Nov 2, 2019 - Jun 11, 2020	88 (2.81%)	87 (2.86%)	106 (1.90%)
Jul 15, 2019 - Nov 2, 2019	4 (0.35%)	3 (0.28%)	8 (0.39%)
% Change	2100.00%	2800.00%	1225.00%
(not set)			
Nov 2, 2019 - Jun 11, 2020	29 (0.93%)	29 (0.95%)	29 (0.52%)
Jul 15, 2019 - Nov 2, 2019	48 (4.23%)	48 (4.45%)	48 (2.33%)
% Change	-39.58%	-39.58%	-39.58%
India			
Nov 2, 2019 - Jun 11, 2020	27 (0.86%)	26 (0.86%)	33 (0.59%)
Jul 15, 2019 - Nov 2, 2019	5 (0.44%)	5 (0.46%)	9 (0.44%)
% Change	440.00%	420.00%	266.67%
France			
Nov 2, 2019 - Jun 11, 2020	20 (0.64%)	20 (0.66%)	20 (0.36%)
Jul 15, 2019 - Nov 2, 2019	0 (0.00%)	0 (0.00%)	0 (0.00%)

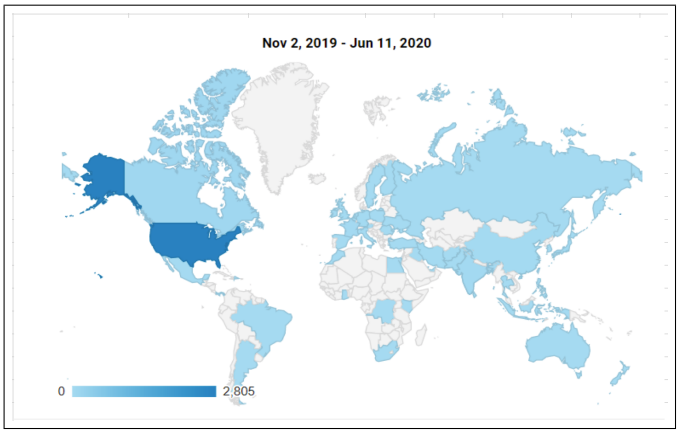

Figure 4. Map overlay about locations of users from Google Analytics.

Google Analytics was a helpful tool to process the evaluation of the open-access, Web-based Military REACH platform.

The process evaluation provided information about the ways to keep users engaged, marketing strategies, and the aspects of the platform that required improvement.

VI. CONCLUSION AND FUTURE WORK

Google Analytics results helped the Military REACH team analyze the website's usage to serve military families better. It shows that after adding more features to the search, function users are using the website in a practical way and spending more time on the website. Compared to the first two years, website usage almost tripled last year.

According to the Google Analytics results, 31% of users have access to the website through their phone. Therefore, to facilitate the accessibility of Military REACH resources, the team is investigating a mobile application (app).

In the future, Military REACH plans to conduct a pilot testing of a newly developed mobile app that will be used for the dissemination of REACH reports, mainly Translating Research Into Practice (TRIP) reports. We will conduct an efficacy study to examine the impact of our mobile app and TRIP reports specifically for helping professionals who directly serve military families. Survey data will be collected from participants (i.e., primary data collection) using Qualtrics (a survey software used at Auburn University), a secure online data collection tool. This data will help us understand the users' military family knowledge better, their confidence in serving military families, their satisfaction and reaction to the app, and make the military family research accessible to everyone.

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