Lab 1 – Research Link: The Undergraduate Research Web Application

Kevin Ashley

Old Dominion University

CS411W

Janet Brunelle

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Introduction

Research is the foundation of new development and the expansion of current knowledge. Universities that heavily focus on research understand the importance of student involvement at both the graduate and undergraduate level. It is the contributions of faculty and students that drive progress in areas such as science, technology, engineering, and mathematics. For instance, at public universities between the years of 2012 and 2013, research resulted in more than 13,322 patent applications, 522 start-ups, 3,094 licenses issued and 3,278 patents awarded (American Academy of Arts & Sciences, 2016).

The Council of Graduate Schools has recently reported a significant increase in graduate enrollment stating that “first-time graduate school enrollment was up 3.5 percent in 2014 from the previous year” (Flaherty, 2015). As the interest in graduate education continues to rise, universities are aiming to intensify their focus on the development of future candidates by connecting them with more research opportunities during their undergraduate career. The participation in undergraduate research can prepare a potential student with the experience needed to be successful against the rigorousness of a graduate level program.

The uptick in the effort to attract more students to undergraduate research is not free from complications. In fact, many issues can contribute to the decrease in the number of students seeking out and applying for research positions. The delivery method of available openings plays a vital role when attracting applicants and, therefore, could be considered the main culprit of missed opportunities. In the past, faculty members have relied on office bulletin boards or word
of mouth to disperse related information. However, to reach as many students as possible, these dated delivery methods must be abandoned and replaced with modern solutions.

One other issue surrounding the miscommunication between faculty members and potential participants is the lack of persistence with deadline communication. Once a student has received information via word of mouth, bulletin board post or email, there is often little follow-up from faculty regarding a student’s interest or approaching submission deadlines. With the amount of current undergraduate research opportunities available, it is impossible to assume that any faculty member could keep track of all students willing to participate.

Figure 1: Current Process Model. This figure illustrates the issues found in the current process of distributing research opportunity information.
The proper solution to the issues previously mentioned must meet specific criteria to be considered a success. The most important characteristic required to be present is the ability to distribute information directly to interested participants. Doing so will decrease the amount of missed opportunities due to the miscommunication between students and faculty members via dated delivery methods. Automatic notifications should also be built in to notify users via email and an in-app notification center of newly created opportunities that may be of interest to the student and approaching submission deadlines for applications not already completed. Universities and students should receive recognition for their work and achievements associated with their involvement. Therefore, having the ability to showcase success and highlight student accomplishments would be a needed feature to promote and encourage more participation.

The purpose of Research Link is to provide a university with a more streamlined process for delivering valuable information to current students regarding possible undergraduate research positions. Research Link will offer the student the ability to search for current openings as well as receive notifications of newly matched opportunities based on their profile content. They will also receive notifications of approaching submission deadlines. Faculty members will have the ability to add new opportunities and receive a list of potential candidates based on student profile matching results. The proposed solution will be prototyped for the Department of Computer Science at Old Dominion University to evaluate its' effectiveness in solving the issues at hand.
Product Description

Research Link is a web-based application that will enable direct distribution of research opportunity, internship, scholarship and skills camp information between faculty members of universities and qualified student candidates. Providing this convenient form of communication, coupled with intellectual matchmaking capabilities, Research Link aims to help increase student participation rates in undergraduate research. Alongside current or future opportunities, a news component highlights past accomplishments of departments and students. Promoting these achievements will raise awareness of Old Dominion University's participation in innovative research. This application supports the objective of increasing ODU’s research program affinity among current and future students by helping to confirm ODU’s position as a prime location for advanced research.

Product Features and Capabilities

There will be three different levels of interaction associated with this application. These user types will determine the capabilities allowed for each feature found in Research Link. The feature that is considered to be the focal point of development is the creation of opportunities and sharing of information. Users deemed as administrators will be responsible for maintenance and quality control over the lifespan of the product. Administrative users will be allowed to create/remove opportunities, create/remove user accounts, assist in password retrieval, backup application data, and archive old application data. General maintenance tasks would also include the addition/removal of academic departments, courses and study concentrations.

Faculty user types play a pivot role in opportunity creation and information sharing. Faculty members are often contacted by external agencies needing qualified candidates to fill open
positions and will, therefore, have the capability of creating and editing research listings. They will also have the ability to create a profile, share past opportunities in which they were the lead researcher, share the courses they are teaching and search for candidates based on information found in student profiles. Consequently, students have a clearer view of the faculty member they may potentially work with in the future. The news and successes component mentioned previously will be solely controlled by faculty. They will have the ability to add, view or update departmental and student achievements that will be displayed to both registered and non-registered users.

Students will also have the capacity to share information about themselves by creating a profile. These profiles will consist of data points such as courses taken by the student, current grade point average, on campus or distance learning designation, past opportunity participation and areas of interest. The searching and filtering of opportunities within the application will help them pinpoint their most desired positions. Students will receive email and in-app notifications from Research Link when matched with an opportunity entered into the system or if deadlines to apply for any matched or user saved opportunities are approaching. Development emphasizes accessibility given the desire of the customer to reach as many users as possible. Students, faculty, and administrators will be able to access Research Link from any device due to its' responsiveness abilities with the Bootstrap framework.
Figure 2: Solution Process Model. This figure illustrates the flow of information for students and faculty through Research Link

Major Components (Hardware/Software)

There are minimal hardware components needed for this particular application. These components consist of a server, network connection and database storage space. It is the assumption that these technologies currently exist at the customer's host site. Therefore, the deployment of Research Link will only require a small amount of configuration of existing
resources. The end user will need a device capable of connecting to the internet to interact with this application.

The software components will follow a LAMP (Linux, Apache, MySQL, and PHP) stack structure. LAMP is a popular open source choice for the development of web applications and will serve as the foundation of Research Link. For the purpose of this product, it is under the assumption that these components currently exist at the customer's host site. However, it should not be a deterrent from the usage of this application as these software components can be installed and configured with minimal effort from the customer’s Information Technology department.

**Identification of Case Study**

Research Link is a web application developed for Old Dominion University, specifically the Department of Computer Science, to aid in the distribution of research, internship, scholarship, and skills camp information to interested students. The objective of this application is to increase the participation rate of students in undergraduate research at Old Dominion University. The participation in undergraduate research not only provides students with a greater understanding of the topics in their field of study, but it can also improve the chances of students ultimately deciding to pursue a graduate level education. The University of Michigan recently completed a study involving their Undergraduate Research Opportunity Program that revealed students who participated in some form of undergraduate research were 26 percent more likely to pursue a graduate degree (Piazza, 2016).

There are a few direct competitors of this proposed solution. Pivot is a web-based tool that provides some of the same functionality as Research Link. Current opportunities are regularly
updated, and the ability to receive notifications of new opportunities and critical deadlines are similar to both products. However, Pivot fails to deploy a departmentally focused solution and relies on data mining algorithms to populate opportunities that may return convoluted or inaccurate results. Furthermore, some universities, such as Harvard and Penn State, have implemented websites with a sole purpose of listing current openings.

Research Link will take a more intellectual, departmentally focused approach by applying student and opportunity matching capabilities and automatic notifications to optimize the distribution of information. The Research Link prototype will be developed for the computer science department at Old Dominion University to demonstrate a proof of concept and evaluate the level of efficiency of the modified information distribution process. This application has the potential to be marketed to other research centered universities and agencies such as the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA).

**Product Prototype Description**

There are minimal differences between the functionality of the prototype and real world application. The main variance between the two is the ability of the application to validate registering users against a database of active faculty and students at Old Dominion University. Banner is ODU’s administration system that provides controlled access to financial, student and faculty data. The real world application will take the information submitted via Research Link’s register form and validate it against user data found in Banner to ensure that the individual attempting to gain access to the application is indeed an active member of the ODU community.

This obligatory validation will also deter non-faculty members from registering as a faculty member to gain a higher level of access. However, in the prototype version, the registration of
users will be validated against a mock Banner database populated with simulated user information as the interface between Banner and Research Link has not yet been developed. The other capabilities and functionality will be identical between the two and are included in the prototype to evaluate its candidacy as a replacement for the current process found at Old Dominion University. The prototype will simulate the ability of the application to handle multiple concurrent requests for usage, account creation by all user types, research opportunity creation, student matching capabilities, automatic notifications and displaying news/highlights.

Prototype Architecture

The hardware required for the Research Link prototype will consist of a virtual machine running on the computer science servers at ODU. The virtual machine is sufficient in mimicking the production environment needed for the product. Email notifications will be sent using Google’s Gmail servers with the account oduresearchlink@gmail.com. During the demonstration, it is possible to access the prototype from any internet connected device.

There will be numerous pieces of software needed to produce a functional prototype. Apache2 is the web server selected to host the application and will reside within the virtual machine mentioned previously. MySQL will be used to store the data collected from the various forms found throughout the application. The server side scripting language chosen to interact with the data found in the MySQL database is PHP version 7.0. Laravel version 5.2 will be utilized to organize the application into a Modal, View, Controller (MVC) format. This framework also allows for rapid development of the current design and scalability for future functionality. Composer, the PHP dependency management software, will be installed to ensure all necessary dependencies will remain up-to-date and functional.
Figure 3: Prototype Major Functional Components. This figure illustrates the major functional components found within the Research Link Prototype.
Prototype Features and Capabilities

The prototype will demonstrate key features for the purpose of evaluating its effectiveness in solving the problem at hand and determining its feasibility of implementation. The customer can create, edit, and view research opportunities, profiles, and news articles. Additionally, the prototype will demonstrate the handling of automatic notifications for newly created opportunities and opportunity deadlines. The applications' responsive capabilities display accessibility from multiple devices with different screen resolutions. Furthermore, the prototype validates newly registered user data against a simulated Banner database.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Real World Product</th>
<th>Prototype</th>
</tr>
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<tbody>
<tr>
<td>Create Opportunities</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Profile Creation/Update</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Opportunity Search/Filter</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Automatic Notifications</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>News and Highlights</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Web Accessibility</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mobile Accessibility</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Banner Interface</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 1: Real World Product vs. Prototype. This table illustrates the comparison of features found in the real world application and prototype.
Prototype Development Challenges

There is a possibility of encountering challenges during the development of this prototype. Although there will not be any real integration with ODU's existing systems, developing a prototype that closely mimics how the application will interact with those systems during deployment is a crucial goal. Developing a codebase with a high level of modularity will allow the ability to swap out the simulated Banner database connection with the actual product without affecting the application’s functionality.

Another development challenge is the knowledge deficiency of web based programming languages, such as HTML, CSS, JavaScript, and PHP, among current team members. There is also a lack of experience surrounding web application security, testing, and deployment. Therefore, to combat these challenges, a team lead with suitable experience has been assigned to each phase to ensure code quality and the deliverability of the prototype.
## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Apache2 Server</td>
<td>Web server software.</td>
</tr>
<tr>
<td>Banner</td>
<td>Old Dominion University’s Administration System that provides controlled access to financial, student and personnel data. This system is only available to Faculty and Staff.</td>
</tr>
<tr>
<td>Bootstrap</td>
<td>HTML, CSS and JS framework for developing a responsive web-based project.</td>
</tr>
<tr>
<td>CSS</td>
<td>Cascading Style Sheets is a style sheet language used for describing the presentation of a document written in a markup language.</td>
</tr>
<tr>
<td>HTML</td>
<td>HyperText Markup Language is the standard language for creating web pages and applications.</td>
</tr>
<tr>
<td>Laravel</td>
<td>A robust MVC PHP framework, designed for developers who need a simple and elegant toolkit to create full-featured web applications.</td>
</tr>
<tr>
<td>MySQL</td>
<td>Open source relational database management system.</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation (NSF); Offers funded research opportunities through Research Experiences for Undergraduates (REU).</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration; Offers Undergraduate Research Fellowships and Internships</td>
</tr>
<tr>
<td>PHP</td>
<td>Server scripting language for making dynamic and interactive Web pages.</td>
</tr>
</tbody>
</table>
References

