VIRTUAL ACCESS TO STEM CAREERS (VASC): A COMPREHENSIVE WEB APPLICATION.

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ABSTRACT

Virtual Access to STEM Careers (VASC): A Comprehensive Web Application for Early STEM Exposure. Hollock, David, 2023. Capstone Paper, University of North Carolina Wilmington.

The rapid evolution of technology and its integration into education has opened doors for innovative approaches to teaching and learning. The Virtual Access to STEM Careers (VASC) project aims to harness the potential of virtual reality (VR) to provide students in grades 2-5 with immersive experiences related to STEM careers. This paper presents the development and consolidation of a comprehensive web application that amalgamates various facets of the VASC project, including grant research, application processes, pedagogical resources for educators, and developmental code for software engineers. The primary objective of this endeavor is to offer a centralized platform that facilitates the seamless implementation of the VASC program in educational settings and provides a tool to help obtain further funding. Furthermore, this study delves into the usability of the web application, ensuring its design and functionality align with the needs of its diverse user base, from educators to developers. Preliminary findings suggest that early exposure to STEM careers through VR, when combined with structured classroom instruction, can significantly enhance students' perceptions and aspirations towards STEM fields. The VASC web application, with its comprehensive approach, stands as a promising tool to bridge the gap between traditional education and the dynamic world of STEM, fostering the next generation of innovators and scientists.

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CHAPTER 1: INTRODUCTION

1.1 Background and Overview of VASC

The world of science, technology, engineering, and mathematics (STEM) is vast and ever evolving. Early positive experiences in these fields can significantly influence a student's future career trajectory. Recognizing this, the Virtual Access to STEM Careers (VASC) project launched at UNCW, is a collaborative endeavor between the Computer Science department and the Watson College of Education (WCE). Supported by the National Science Foundation (NSF) under award number 1850430, VASC seeks to reshape the way students perceive and engage with STEM subjects.

VASC's innovative approach combines traditional learning methods with immersive virtual reality experiences. The program begins by introducing students to a specific STEM career, allowing them to delve deep into its intricacies. For instance, the current iteration focuses on the role of a park ranger working with sea turtles. Schools receive a comprehensive 5-day course package, complete with a curriculum, presentations, and hands-on labs (Figure 1). Upon completing this foundational phase, students embark on a virtual journey using the Oculus headset, stepping into the shoes of a park ranger (Figure 2). This immersive experience, built upon the knowledge acquired over the previous five days reducing the cognitive load, aims to provide students with a tangible connection to STEM careers, moving beyond abstract equations and theories (Ebrahimi et al., 2022).

The overarching goal is to instill a renewed sense of purpose and enthusiasm for STEM subjects in students. It will also allow students in underserved populations to experience technologies and experiences which many times are not available in their learning settings. An example of this became clear while conducting an experiment at

D.C. Virgo here in Wilmington. Even though from anywhere in Wilmington you are at most a 20-minute ride to the ocean at least 40% of students indicated they had never even been there.

Figure 1. VASC's 5-Day Course Package.

The application purposed will serve as a one-stop hub, streamlining the organization, access, and dissemination of project resources. This project is time sensitive being that only a few of the researchers from the last round of funding are still students here at UNCW. If this application is not completed before these students leave valuable information and connection to project will be lost.

Figure 2. VASC Virtual Journal

In conclusion my hypothesis is the development of a specialized web application for the Virtual Access to STEM Careers (VASC) project will significantly enhance the project's marketability, collaborative development process, and accessibility for educators. This web application will serve as a central platform, enabling more efficient

collaboration among authors, researchers, and developers, and will provide educators with an intuitive and resource-rich interface for implementing VASC in their classrooms. As a result, this will lead to a broader adoption of the VASC project and an overall improvement in the delivery and impact of STEM education for students in grades 2-5.

1.2 Personal Motivation

My journey at UNCW, particularly in the CSC-550 Software Engineering course, has equipped me with the skills needed to tackle complex software challenges. I believe that a well-designed web application can be transformative, turning operational challenges into opportunities for growth and outreach.

This capstone project offers me the chance not only to apply the programming skills I have learned here in a real-world context but also to contribute meaningfully to the VASC initiative, ensuring its legacy and impact continue to flourish. I believe strongly that instruction combined with gamification is going to be a powerful force in education for years to come.

Finally, I am excited to take a project from inception to completion that I can use as portfolio piece and experience to draw on while entering my new career.

CHAPTER 2: REVIEW OF LITERATURE REVIEW AND ANALYSIS

In starting to explore this project it became clear that unique different user roles meant this application could not be a generic undertaking. It was decided that a survey of grant authors, developers, and educators who have had experience with the current organization would be helpful along with a few outside users to gain insight for development. This would also lead to key features needed that otherwise may have been left out.

This data will help provide a robust final product that focuses on the needs of VASC and the academics of usability in today's changing web design landscape. This literature review will explore the best current design and usability practices. Also, because a significant goal of these research projects is to solicit funding it will explore some current marketing practices as well.

While VASC's mission is clear and its potential impact profound, the project faces significant operational challenges. The vast amount of content, ranging from curriculum materials and presentations to virtual reality assets and research data, is scattered and lacks a centralized system for organization. This fragmentation not only hinders the efficient use and dissemination of resources but also poses challenges in showcasing the project's achievements and potential to prospective funders and collaborators.

The multidisciplinary nature of VASC, involving grant authors, programmers, digital artists, and educators, necessitates a cohesive platform where all stakeholders can access, update, and share essential resources. The absence of such a platform has led to inefficiencies, with team members often struggling to locate specific assets or track the project's progress. Furthermore, without a unified showcase of the project's milestones

and achievements, marketing VASC to potential funders and the broader educational community becomes a daunting task.

This capstone project aims to address these challenges by developing a comprehensive web application dedicated to centralizing all aspects of the VASC initiative. The application will serve as a one-stop hub, streamlining the organization, access, and dissemination of project resources. By ensuring that all materials are easily locatable and presented in a coherent manner, the application will not only enhance the project's internal efficiency but also bolster its external outreach efforts.

These three goals are key in the development of this project.

1. Efficiency:

   With all resources centralized, team members can swiftly locate and utilize necessary assets, reducing time spent on searching and increasing productivity.

2. Collaboration:

   A unified platform facilitates better communication and collaboration among the diverse VASC teams, ensuring that everyone is aligned with the project's goals and progress.

3. Marketing and Outreach:

   A well-organized showcase of VASC's achievements, resources, and potential can significantly enhance its appeal to potential funders, collaborators, and the broader educational community.

2.1 Best Web Design Practices

"Best web design practices" refers to a set of guidelines, strategies, and standards that web designers follow to create effective, engaging, and user-friendly websites. These

practices encompass various aspects of web design, including visual design, user interface (UI) and user experience (UX) design, accessibility, performance optimization, and content strategy. The goal is to enhance the usability, functionality, and aesthetic appeal of websites, ensuring that they effectively serve the needs and preferences of users while achieving the intended objectives of website owners or developers. Several websites such as accessiBe.com are available to audit the project for compliance. First impressions and feelings of credibility are closely tied to website design (Figure 3).

Figure 3. Credibility within Website Design.

Incorporating user-centered design (UCD) is paramount in web development, as it ensures that the website not only meets the needs and expectations of its users but also creates an intuitive, accessible, and user-friendly environment. This approach, championed by experts such as Don Norman, involves a deep dive into user research, which encompasses understanding the users' behaviors, needs, and motivations. Usability testing and iterative design are integral to this process, allowing for the refinement of the website through successive prototypes, ensuring that each iteration is more aligned with the user's mental model and expectations.

Accessibility is another cornerstone of modern web design, particularly for projects with NSF funding, which necessitates adherence to ADA guidelines. Ensuring web accessibility means that all users, including those with disabilities, can access and interact with the website seamlessly. This involves implementing semantic HTML, providing alt text for images, and ensuring keyboard functionality, among other strategies (WWW Consortium, 2018). The ADA standards for website development underscore the principle that digital platforms should be as navigable and understandable for individuals with disabilities as for those without, a principle that is not only a legal requirement but also a moral imperative in inclusive design (ADA.gov, 2023).

Navigation is a critical aspect that directly impacts user experience. Clear and intuitive navigation structures enable users to easily locate information and complete tasks. This involves a well-organized layout, clear labeling, and the inclusion of a search feature to facilitate quick access to information. As web design expert Steve Krug famously said, “Don’t make me think,” the navigation should be self-evident, reducing the cognitive load on the user and making the experience as effortless as possible (Krug, 2000).

Performance is another key factor that significantly affects user satisfaction and search engine ranking. As indicated by a survey from Unbounce, 70% of users consider page load speed when visiting a website, with a preference for load times between zero to four seconds, and ideally two seconds for optimal user experience (Hubspot 2019). To achieve this, strategies such as optimizing images, leveraging browser caching, and minimizing HTTP requests are employed to enhance website speed and performance.

Content strategy is about organizing, structuring, and presenting content in a way that communicates the intended message clearly and efficiently to the user. For this

project, the content will be tailored to the specific user roles identified, such as educators, ensuring that the content is relevant and resonates with the audience.

Visual design also plays a significant role in enhancing the user's interaction with the website. Employing aesthetically pleasing visual elements, such as colors, images, and typography, not only enhances the website's look and feel but also engages users on an emotional level, a concept that Don Norman refers to as emotional design. This aspect of design is crucial as it can influence user perceptions and experiences, making the website not just a tool but a pleasurable place to visit (Norman, 2004).

Lastly, testing and feedback are essential for continuous improvement. This involves regularly evaluating the website with real users, gathering feedback, and refining the user experience. This iterative cycle of testing and feedback ensures that the website remains aligned with user needs and expectations, thereby enhancing overall usability, functionality, and satisfaction.

By weaving together these best practices—UCD, accessibility, navigation, performance, content strategy, visual design, and testing and feedback—the project aims to deliver a website that is not only functional and compliant with standards but also delightful to use, ensuring a positive and productive experience for all users.

2.2 Integration of Web Design and Marketing:

In the realm of web development, particularly for applications seeking continued funding, the intersection of marketing and design is crucial. Cohesive branding is a fundamental strategy that bolsters brand recognition and trust—a critical factor when dealing with educational grants, which are often perceived as unproven products. A consistent visual identity across the website, involving the strategic use of logos, colors, and messaging, not only strengthens the brand but also fosters credibility. Marty

Neumeier in “The Brand Gap” emphasizes the importance of integrated brand communications, stating, “The brand is not what you say it is. It’s what they say it is.” This underscores the role of cohesive branding in shaping public perception and trust in the brand (Neumeier, 2005).

The user experience (UX) on the website is another pivotal element that can significantly influence conversion rates. Unlike traditional websites where conversions may be measured by sales, in this context, conversion could mean the desire for more information or a request for a demonstration. To optimize UX for these outcomes, clear calls to action, simplified forms, and compelling content are essential. These elements guide users toward the desired action, enhancing the likelihood of conversion. As Jesse James Garrett, author of “The Elements of User Experience,” points out, a successful UX “seamlessly merges the services of multiple disciplines, including engineering, marketing, graphical and industrial design, and interface design” (Garrett, 2010).

Furthermore, the application of web analytics is instrumental in monitoring user behavior and the effectiveness of marketing campaigns. By analyzing data, one can gain insights that enable continuous improvement in both web design and marketing strategies. It is essential to ascertain whether the website is reaching the intended demographic, and if not, to understand what adjustments need to be made. Google Analytics is a powerful tool in this regard, offering a wealth of data that can inform decisions and strategies. Avinash Kaushik, a digital marketing evangelist for Google, advocates for the power of analytics, stating, “It’s not what the data tells you, it’s about what it whispers.” This highlights the nuanced understanding required to interpret analytics data and apply it effectively to improve web presence and marketing efforts.

In summary, the synergy between cohesive branding, user experience, and

analytics forms the backbone of a successful web application. By applying these strategies thoughtfully, the project not only aligns with its goals but also positions itself strongly for continued funding and growth. Each element, from branding to data analysis, works in concert to create a compelling, trustworthy, and effective online presence that resonates with users and stakeholders alike.

2.3 Educators and Website Usage for Teaching and Lesson Preparation

In the digital age, the educational landscape is continually reshaped by the integration of online resources into teaching and lesson preparation. Educators, as primary users of a myriad of educational websites, are at the forefront of implementing innovative digital tools (Roblyer & Doering, 2013). These websites, rich with resources such as lesson plans, educational games, interactive simulations, and instructional videos, have become invaluable in the modern classroom.

The role of websites in education extends beyond mere repositories of information; they are dynamic platforms offering diverse teaching resources. Teachers can readily download materials that align with curriculum standards, from comprehensive lesson plans to worksheets, which not only save time but also enhance the quality of instruction (Mishra & Koehler, 2006). A well-constructed website can become a one-stop-shop for educators looking to deepen their subject matter expertise, acknowledging the time constraints educators face, and aiming to provide streamlined, efficient tools that fit into their busy schedules without adding undue burden.

Interactive learning tools available on websites have revolutionized how educators engage with students. These tools provide hands-on learning experiences that are both engaging and informative, serving as a bridge between theoretical knowledge and practical application (Siemens, 2005).

Collaboration and networking represent another significant aspect of educational websites. These online platforms break down traditional barriers of time and location, enabling teachers to connect with peers globally. This connectivity fosters the sharing of resources and teaching strategies and encourages collaboration on educational projects and initiatives.

The integration of multimedia into lessons is yet another advantage offered by websites. Educators can enhance their teaching with videos, animations, and audio files that complement textual content, catering to various learning styles and preferences. However, the reliance on websites in education is not without its challenges and considerations, such as ensuring online safety, evaluating the credibility of resources, and managing screen time for students (Roblyer & Doering, 2013).

In conclusion, as educators increasingly turn to websites that pioneer the incorporation of VR into classrooms, digital resources have become an essential component of effective teaching strategies. The thoughtful application of these tools, as seen in the VASC project, will truly enhance teaching and prepare students for the future.

2.4 Developers or Researchers and Website Usage for Collaboration

In the modern world, successful developmental and research projects are woven with collaboration threads. The digital era has ushered in websites and online platforms instrumental in bolstering collaborative efforts among developers and researchers (Fitzgerald & Stol, 2017). These tools are not just conveniences; they are essential components that streamline communication, facilitate seamless information sharing, and ensure efficient resource management.

Project management websites such as Jira, Trello, and Asana have become staples in the developer and researcher toolkit, serving as the digital equivalent of a central

command center for organizing tasks, tracking project progress, and ensuring the timely completion of milestones (Fitzgerald & Stol, 2017). The VASC project has experienced the benefits of implementing Trello and task cards within GitHub. However, the challenge remains to house these tools in a location accessible for future researchers to review and build upon.

Code sharing and version control platforms, notably GitHub and Bitbucket, are also pivotal in the collaborative process. They provide a structured environment where developers can work on coding projects collectively (Spinellis, 2012). With version control systems, multiple contributors can work on a project simultaneously, managing changes and maintaining the integrity and consistency of the project codebase (Dabbish et al., 2012).

Documentation and knowledge sharing are equally critical to the collaborative process. Platforms like Confluence and Google Docs enable the creation, sharing, and collaborative editing of project documentation, promoting consistency and clarity throughout the project's lifecycle (Fitzgerald & Stol, 2017).

In conclusion, the strategic use of websites is vital in enhancing collaboration among developers and researchers. From project management to code sharing, and from communication to documentation, these online platforms support the multifaceted nature of collaborative work. By embracing these digital tools, developers can craft solutions that not only meet the immediate needs of the project but also lay a foundation for future innovation and development.

2.5 Data Collection Methods for Usability Testing

Usability testing is a user-centered design technique that evaluates a product by testing it on users. This method focuses on measuring the usability of the product, which

includes the ease of use, comprehension, navigation, and overall satisfaction of the user with the product. Jakob Nielsen, a prominent figure in the field of usability engineering, has extensively discussed the importance of usability testing, stating, “Usability is a quality attribute that assesses how easy user interfaces are to use” (Nielsen, 1993). The data collected during usability testing can be categorized broadly into two types: quantitative and qualitative.

Quantitative methods involve collecting numerical data that can be used to measure and compare the usability of different design iterations. This can include data such as task completion rates, error rates, time on task, and other metrics that can be objectively measured. As Nielsen elaborates, “Quantitative usability studies typically aim to answer questions about how many users perform a task, how long they take, and how many errors they make” (Nielsen, 2001).

One common quantitative method is the use of analytics tools, which can track and aggregate user interactions with the product in real-time. This data is invaluable for identifying patterns and trends that can inform design decisions.

Qualitative methods focus on collecting non-numerical data that provide insights into the user’s attitudes, feelings, and experiences with the product. This type of data is often collected through methods such as interviews, open-ended survey responses, and think-aloud protocols, where users verbalize their thought process while interacting with the product.

Steve Krug, another authority on web usability, advocates for the “think-aloud” protocol as a simple yet powerful tool to understand user behavior. In his book “Don’t Make Me Think,” Krug emphasizes the importance of observing real users as they interact with the product: “Watching one person use your site is more informative than

reading a thousand expert reviews" (Krug, 2000).

The most effective usability testing programs often combine both quantitative and qualitative data collection methods. This approach allows researchers to not only have metrics on performance but also to understand the reasons behind the users' behaviors. Rolf Molich, another notable expert in the field, has collaborated with Nielsen on several occasions and is known for his work on comparative usability evaluation. He suggests that "the best results in usability testing come from testing no more than five users and running as many small tests as you can afford" (Molich & Nielsen, 1990).

In practice, this means conducting iterative testing cycles with small groups of users, collecting a mix of quantitative and qualitative data, and then refining the product based on the insights gained. This iterative approach is echoed by many in the field, including Susan Weinschenk and Dean Barker, who note in their work that "usability testing is a formative process that should be repeated" (Weinschenk & Barker, 2000).

In summary, data collection methods in usability testing are diverse and should be selected based on the goals of the study. The combination of quantitative and qualitative data provides a comprehensive understanding of user interactions and experiences. As these experts highlight, the key to successful usability testing is not in the volume of data or the number of users tested, but in the consistent, iterative application of these methods to refine and improve the product.

2.6 Project Milestones

In justification of this capstone, it is important to note the considerable time, effort, and financial contributions that have been made so far in this initiative (Figure 4). Having a cohesive face for this project will only help continued funding and research.

VASC Milestones

- NSF GRANT AWARD 1850430 - $394,606
- Virtual Access to STEM Careers: Two Preliminary Investigations Publication
- 30+ Student researchers
- 100's of development hours
- 14 Person Summer Reseach Cohort
- 2 Significant experiments with over 50 subjects (DC Virgo /CFCI Wilmington)
- Several Computer Scicence Showcase Presentations UNCW
- SNCURCS Poster Presentation December 2022
- Graduate Capstone - Data Collection Blake Blackport
- Graduate Capstone - Multiple Headset Portal Austin Whittaker

Figure 4. VASC Milestones.

CHAPTER 3: METHODOLOGY

When it was decided that this web application would become a capstone project, this student had already played several of the roles that need to be addressed while involved with VASC specifically researcher, developer, and educator. Looking at those roles each from their perspective desired features began to be mapped out in each. Several unique things for each user group came to light but a general overlap of wants as well. The project is taking shape as a hub. A general information source for everyone which can also focus on the marketing requirement. Three spokes for other more specific sections will be created. Research/Grant Author, Developer, and Educator (Figure 5).

Figure 5. General Marketing Information with Requirement Spokes.

The project adopted a user-centered design approach, a methodological choice informed by its emphasis on end-user satisfaction and practical utility. After initial prototyping a needs assessment, will involve surveys and interviews with current and past participants, seeking qualitative and quantitative data to identify and understand the specific needs of each user category. The subsequent analysis will entail a methodical

breakdown of the collected data, translating user needs into potential features, with a keen focus on identifying commonalities that could streamline the platform's functionality. Iterative testing and feedback will further ensure a viable final product.

The hub-and-spoke model informs the application's architecture, chosen for its centrality of essential features and its allowance for role-specific functionalities. The central hub, focused on general information and marketing, is designed to be dynamic, supporting content updates and user interactions, while providing valuable analytics for continuous improvement.

The developer section is envisioned as a comprehensive resource, including up-to-date tools, accessible API documentation, code repositories, and features that encourage collaborative problem-solving.

The educator section, conversely, emphasizes pedagogical resources, offering functionalities for course creation, student assessment, and interactive learning, all within a user-friendly environment.

The research/grants section stands out as a scholarly resource, providing seamless access to research papers, intuitive grant management tools, and collaborative features, all designed to foster a vibrant research community.

3.1 Technology Stack

The technology stack was selected for its cohesion, flexibility, and robustness, critical for the application's long-term success. The following paragraphs and diagram are a concise explanation of what will be used and why it was chosen. The diagram shows how this stack interconnects to make a functioning product (Figure 6).

Python was an obvious choice for the backend, given its versatility, readability, and the rich ecosystem of libraries and frameworks it supports, making it ideal not only

for current development needs but also for future scalability (Python Software Foundation, 2023).

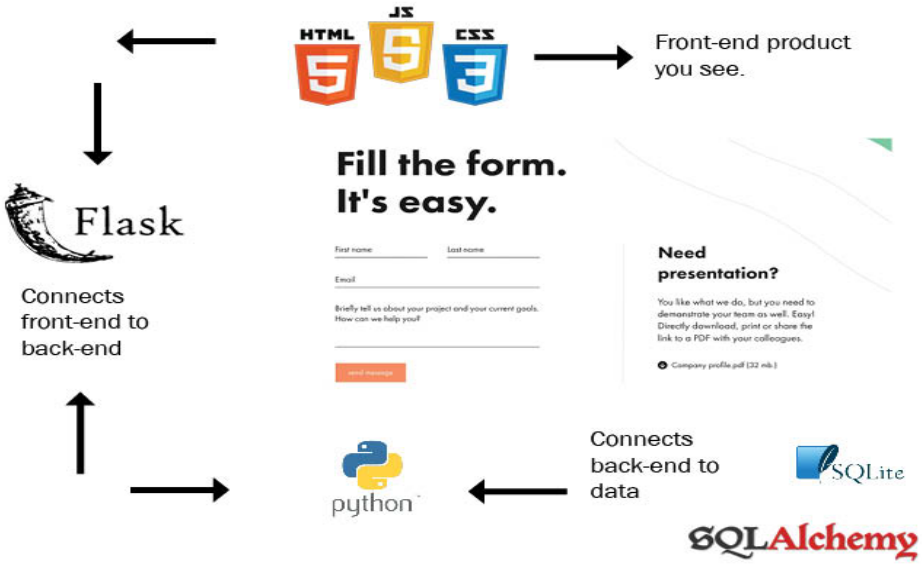

Figure 6. Functioning Product Technology Stack.

Flask, a micro web framework, was chosen for its compatibility with Python, its simplicity, and its extensibility, particularly its built-in features that support essential functionalities such as user authentication, database connectivity and security (Pallets Projects, 2023).

SQLite, known for its self-contained setup, reliability, and speed, was deemed suitable for this application's current scale, with a view for potential migration as the user base expands. SQLAlchemy adds a layer of abstraction, simplifying database interactions through ORM, thus streamlining database queries and manipulations (SQLite Contributors, 2023).

The frontend employs HTML, CSS, and JavaScript, a combination selected for its universal support, ease of use, and ability to create a responsive and engaging user experience (World Wide Web Consortium (W3C), 2023; Mozilla Foundation, 2023).

The selection of this technology stack is designed to ensure that future students can not only maintain but also enhance and scale the application with ease.

3.2 Development Methodology

This project adopts an agile-hybrid development methodology, known for its iterative approach and adaptability to changing project requirements. This methodology emphasizes collaboration, regular feedback, and incremental improvements, making it ideal for a user-centered application. The process begins with meticulous planning, translating user needs and research into a detailed project roadmap. The design phase involves creating prototypes and wireframes, ensuring the application's usability and aesthetic appeal. The development phase is iterative, consisting of several sprints, each resulting in a usable product increment. Rigorous testing at each stage identifies bugs and usability issues, ensuring they are addressed promptly. Finally, the deployment phase involves transferring the application to a live environment, with ongoing monitoring for performance and stability (Stellman & Greene, 2016).

3.3 Testing and Validation

Testing and validation form the backbone of the development process, serving to ensure that the application is not only free from bugs and secure but also delivers a user experience that is both intuitive and satisfying. Employing a variety of testing methods is crucial. Unit testing is conducted to validate individual components, while integration testing ensures that collectively, these components function seamlessly. Furthermore, regression testing is a routine part of the process, performed after updates to guarantee that the latest changes do not disrupt existing functionality.

A critical component of this phase is User Acceptance Testing (UAT), which involves the application being tested by the end-users. This step is invaluable as it

provides direct feedback on the application's performance in real-world scenarios, highlighting areas that require improvement and confirming that the application meets the users' needs and expectations. Given the scope of this project as a solo endeavor, the testing and validation phases will be structured around a carefully crafted timeline to manage and document the process efficiently.

Usability testing is a critical phase in the development of this web application, focusing on evaluating the user interface and the overall user experience. This phase is designed to ensure that the application is easy to use, navigate, and functionally robust, adhering to the principles of user-friendly design that are paramount in today's digital products.

The participant pool for usability testing is diverse, reflecting the application's varied user base. It will have grant authors and research professors who will evaluate the application's capacity to support research and grant-related activities, educational content, and resource accessibility. Student developers who have contributed to the project will examine the technical aspects, such as the ease of accessing current code and the efficacy of the documentation. Teachers, who will primarily engage with the educator section, will offer insights into the application's utility as an educational tool, its effectiveness in delivering content, and its ability to facilitate the VR experience in a classroom setting.

Persona descriptions and working information will be prepared for these roles in order to expand the testing pool as the actual live subjects may not provide a large enough pool for data. In that case this information can be utilized for people to experiment with the site as if they were in that role.

It has been suggested that this pool and the number of roles may be too large to

accommodate in the time that is available. This analysis could be focused on two groups of developers and teachers. They have the most interaction with this project.

Usability Testing Approach. The usability testing will blend qualitative and quantitative methods to ensure comprehensive insights:

- **Heuristic Evaluation**: Usability experts will assess the application against recognized usability principles, identifying potential user interface challenges.
- **Think-Aloud Protocol**: Test participants will verbalize their thoughts while using the application, offering real-time feedback on their experience.
- **Surveys and Questionnaires**: These tools will gather measurable data on user satisfaction and pinpoint areas needing enhancement.
- **User Task Analysis**: By executing defined tasks, we will evaluate the application's intuitiveness and feature functionality.

Feedback Integration Process.

- **Data Review and Categorization**: Feedback will be methodically collected, examined, and sorted. Issues will be prioritized based on their impact and urgency.
- **Prioritization**: Immediate attention will be given to critical issues, especially those that disrupt functionality or significantly impair the user experience.
- **Adjustment Implementation**: Based on the feedback, targeted changes can be made, which may include UI/UX redesigns, functionality improvements, or new feature rollouts.
- **Re-evaluation**: Post-adjustment, further testing to validate the effectiveness of changes and check for the emergence of any new issues.

Maintaining a clear line of communication with all stakeholders is essential. A detailed change log will be kept, documenting all modifications made in response to user feedback. This log will be shared with all participant groups to ensure transparency and to demonstrate the importance of their contributions.

In conclusion, usability testing and feedback integration are fundamental to the project's success. This thorough approach is a testament to our commitment to delivering an application that is not only functional but also user centric. It is through this meticulous development process that the application aspires to achieve widespread adoption and make a significant impact in the educational and developmental sectors**.**

3.4 Website Structure and Content

1. Welcome Page. The welcome page (Figure 7) serves as the initial point of interaction between the user and the application, designed to immediately engage visitors. It will feature an overview of the VASC project, its objectives, and its importance, accompanied by high-quality visuals. This page, while informational, is crafted to evoke curiosity and encourage users to explore the application further.

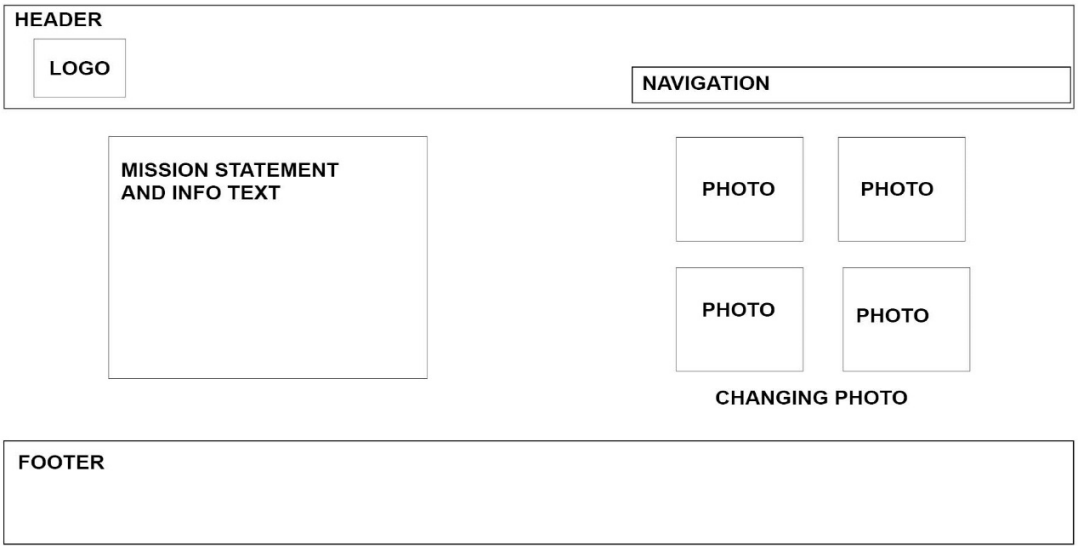

Figure 7. Welcome Page.

2. Signup Page. The signup page (Figure 8) is streamlined yet comprehensive, collecting essential user information to personalize their experience. Fields will include name, email, and optional phone number, ensuring multiple lines of communication. Users identify their role via a checkbox system, with additional fields appearing if "researcher" is selected, asking for the specific years they were involved with the VASC project. Also, this will provide the information for a section to display our researchers (Figure 9) and give them a place to reference in job and academic applications. There is also an opt-in checkbox for users to receive emails and updates, keeping them informed about the latest developments, research findings, and opportunities.

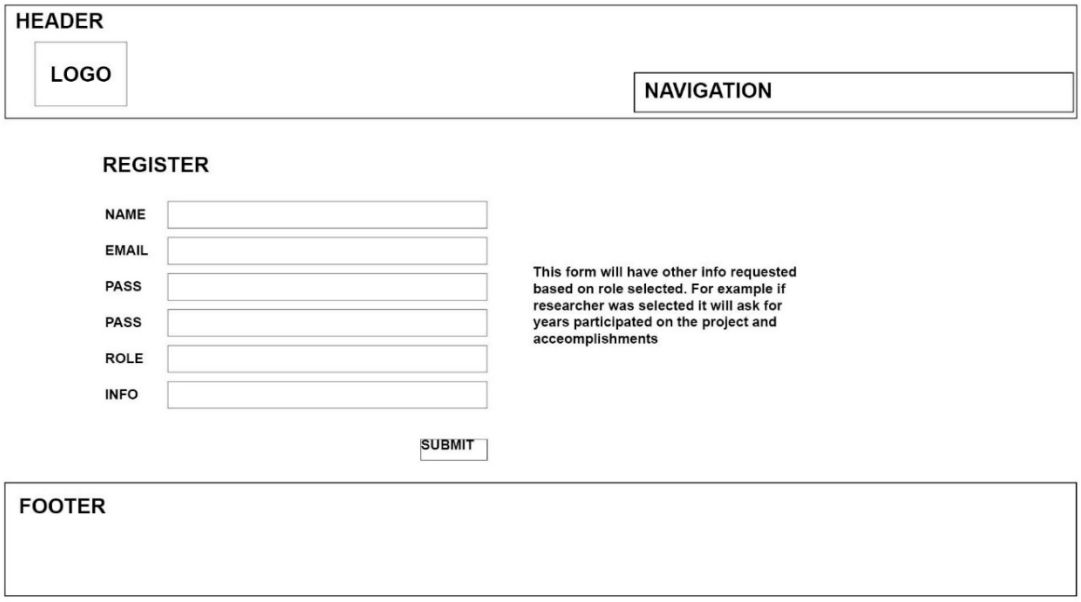

Figure 8. Sign-in Page.

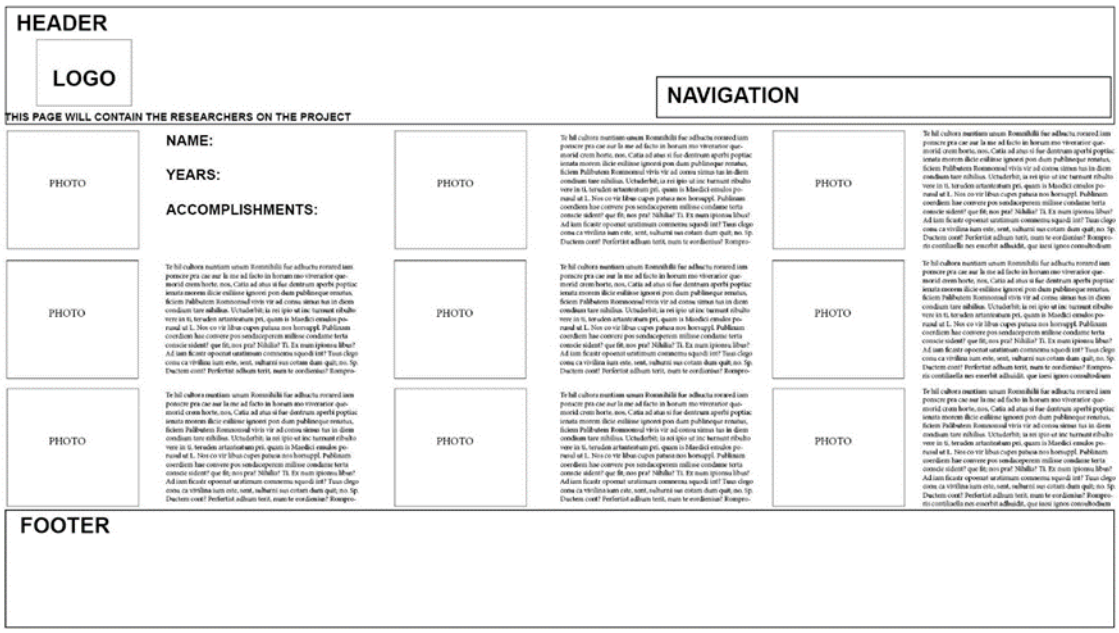

Figure 9. Researcher Showcase.

3. Research Section. A collection of intellectual content, the research page (Figure 10) will be organized to facilitate easy access to various academic materials. This includes database of grants, academic papers, raw experiment data, and publications stemming from the VASC project. An intuitive search function allows users to filter through content based on different criteria, while a feedback feature encourages users to share all criticisms. This section will also feature the collaborating professors and their respective bio/cv information (Figure 11).

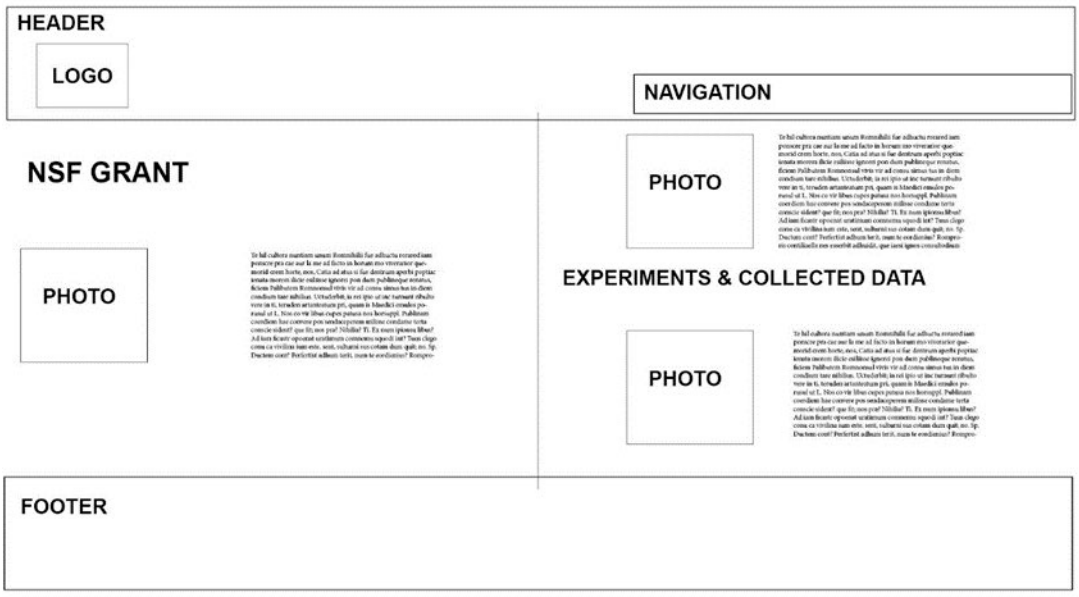

Figure 10. Research Page.

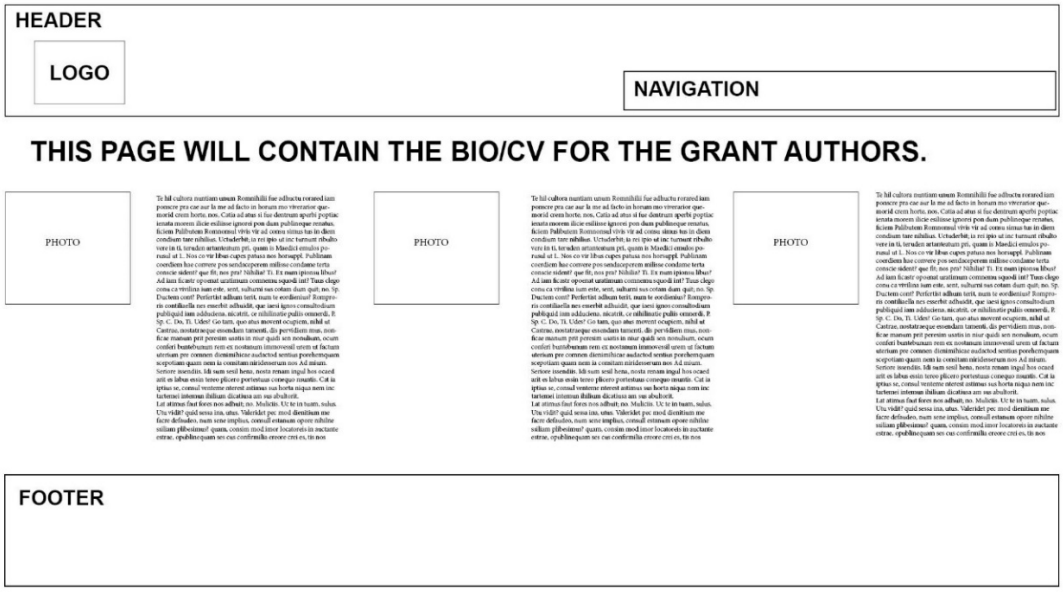

Figure 11. BIO/CV Page.

4. Developer Section. The developer page (Figure 12) is a hub for technical collaboration and resource sharing. It prominently features links to the project's code repositories and frameworks, serving as a gateway for further development and innovation. Additionally, the page hosts a comprehensive guide on best coding practices within the VASC project context, and a forum for proposing and discussing future

development ideas, fostering a vibrant community of contributors.

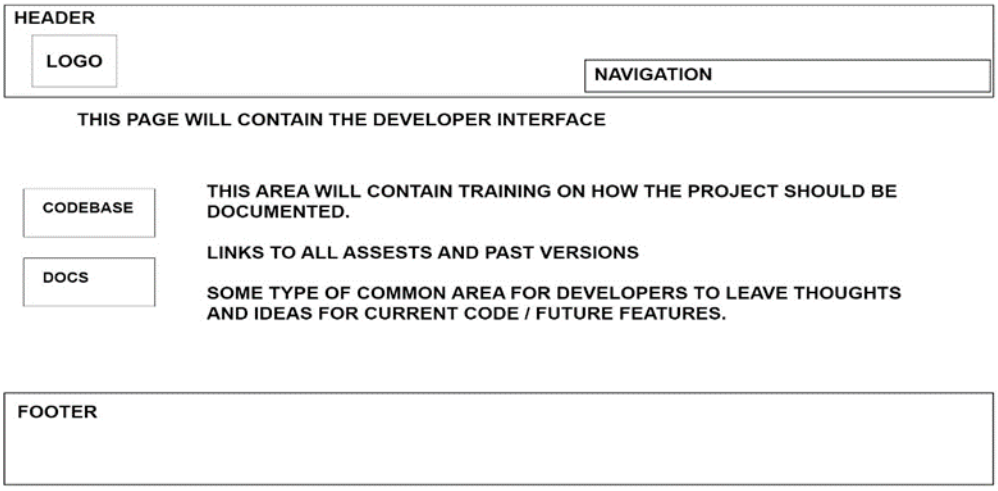

Figure 12. Developer Page

5. Educator/Teacher Section. Functioning as a comprehensive resource for educational personnel, the educator/teacher page (Figure 13) details the process for acquiring the VASC educational package. It presents an in-depth look at the class curriculum, including workbooks, presentations, and an immersive VR game, enhancing traditional learning methodologies. The page also provides essential installation materials visually engaging class posters, and a list of necessary resources, ensuring educators are equipped to integrate this innovative technology into their teaching environments.

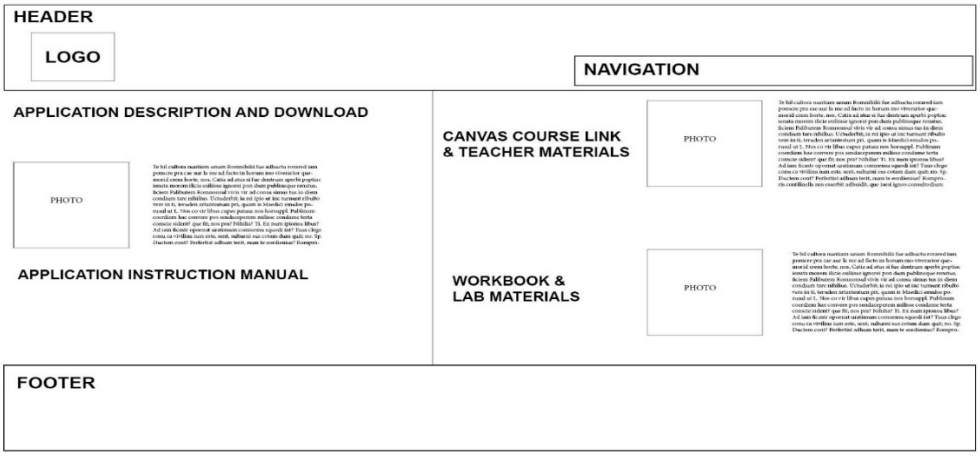

Figure 13. Educator Interface

The website's structure is carefully curated to cater to the distinct needs of its diverse user base. Each section is not just a repository of information but a dynamic space for learning, collaboration, and innovation. By maintaining a user-centric design and continuously updating content, the website aims to sustain engagement and promote a thriving community of researchers, developers, and educators, all contributing towards the overarching goals of the VASC project.

CHAPTER 4: OUTLINE OF COMPLETED PROJECT

During the first semester of this capstone project, the rough plan developed with input from the professors involved with VASC was created providing guidelines to research methodologies and prototype what would become the application. The following sections outline what was accomplished in this spring semester.

4.1 Site Design

The proposal was approved in December 2023 and development began over winter break. The proposed software stack did have one change. In order to provide responsive design and a cleaner look bootstrap CSS was adopted. Creating custom CSS can lead to problems later in functionality from updates along with misunderstanding of code with future developers. Bootstrap is a well-documented and consistently updated framework that is compatible with all major browsers in the marketplace. Using this produced a clean modern looking application that will be customizable by others in future work.

Security of information, especially regarding photos of minor users from our two experiments and certain pieces of code being protected by authors request prompted another notable change. Originally the idea was to provide an on-site repository for code and assets. This could potentially have legal concerns and to alleviate these it was decided to add a second layer of authentication. Keeping these items on university drives meant that a developer would need to be a student with a UNCW email and be granted access by someone on the project. This trimmed out the coding process and adds a simple but efficient solution to this concern.

Development continued until the end of February with weekly meetings, and it was decided that the project could move to the functionality testing phase at this time.

4.2 Functionality Testing – Developer/Researcher Input

This project, as stated previously, consists of four distinct user groups general knowledge, developer, researcher, and educator. Due to the time constraints of this project, it was decided to focus on educators as they will be the largest end user of this project. In order to get additional input from another section it was decided that developers could be the users for functionality testing. Also, the opinions of two grant authors were taken into account as they reviewed the progress of the site along the way.

This testing was of a qualitative nature done in person asking a mixture of direct response and open-ended questions. The group consisted of five developers. Three developers who have worked on this project and two who work in the industry but had no knowledge of this project. Each session lasted approximately 10-15 minutes. This provided feedback for last minute changes before the educator study was conducted.

Overall, the feedback was positive. They found the site to be intuitive and easy to use. Comments were made as to the clean interface along with the ai generated artwork providing a clear message and theme to the site conveying the goals and functionality of the project. This group of users liked the clear sections, so everything required was housed in one place. Developers one, two, and three said it was very helpful and convenient to have all the required links to needed software along with the code repository in one location. Developers four and five also knew what section of the site to visit and felt confident navigating.

Criticisms that came to the surface were small hard to read text in descriptions, the need for a larger navigation bar, and the researcher page in particular needed something. It felt plain to them. This is the benefit of having new eyes look at your project as user blindness is real. This feedback was incorporated into the design. Larger

text, color, menus, and backgrounds were added as seen below in an example of one page.

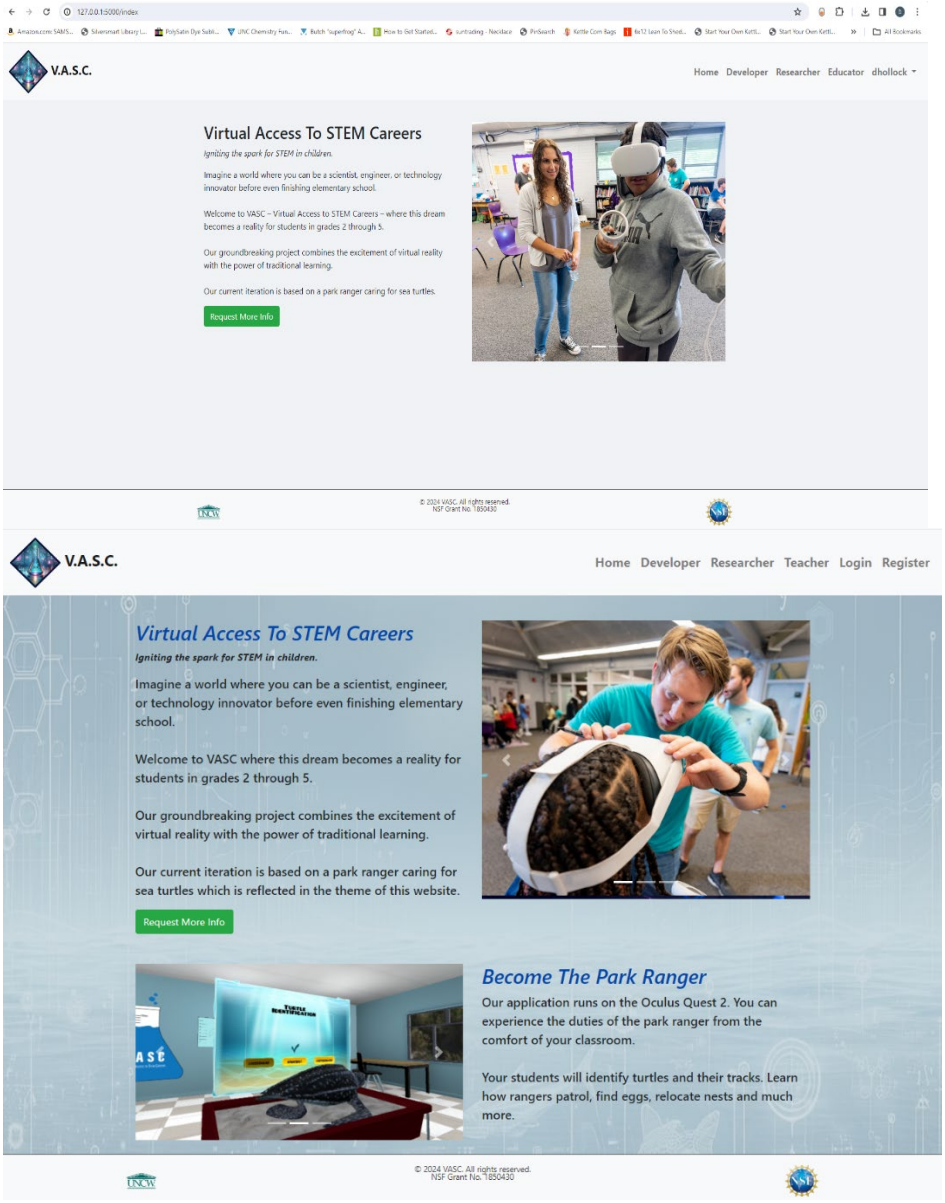

Figure 14. Homepage Before and After.

These improvements were well received, and it was indicated that the site communicated its message in a more effective pleasing manner.

4.3 Educator Usability Study

In this educator usability study, in-person assessments were conducted with a

diverse group of six educators to evaluate our application. The participants included four Montessori teachers, one special education teacher, and one teacher administrator, providing a broad perspective on the usability of the tool across different educational environments.

The study incorporated both quantitative and qualitative research methods to gather comprehensive data. Initially, participants were asked to perform tasks within the application, with each task being timed to quantitatively assess the ease of navigation and task completion efficiency. This objective measurement helped in understanding the practical usability of the application under controlled conditions. Each participant sat at a desk in the school's common area and used the same laptop for the task.

Following the completion of these tasks, a qualitative analysis was conducted through structured interviews. Educators were asked about their overall experience with the application, focusing on aspects such as the intuitive nature of the interface, ease of use, and overall satisfaction. They were also encouraged to express any concerns or dislikes, which provided valuable insights into potential areas for improvement.

Key findings from the study highlighted the application’s effectiveness in educational settings, as well as areas needing enhancement. Based on educators’ feedback, several intuitive features were praised for their ease of use, while some aspects of the interface were identified as needing simplification or more direct navigational cues.

The outcomes of this study have been instrumental in guiding further development of the application. Changes are being implemented to enhance user experience based on the specific feedback provided by the participant educators, ensuring that the application is not only effective but also aligns well with the practical needs of

educational professionals.

4.4 Educator Study Results

The below tables and charts show the results of these tasks and any verbal responses while performing them.

Each teacher was asked to work through 4 scenarios each starting from the homepage. They were timed with a phone stopwatch and any free thoughts uttered about the site were recorded.

The four scenarios were as follows:

1. Navigate to the appropriate section for them in this case teacher and login with a provided username and password.
2. Find out about our research grant and request more information.
3. Find and download a lecture for your class.
4. Find and download the setup manual for the application.

The following table shows these results.

Table 1.

Teacher Quantitative Data

Subject	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Total Time Min
T-1	31.94	58.5	46.54	52	3.15
T-2	55.45	45.21	56.76	69.65	3.78
T-3	43.8	43.8	70.45	58.82	3.61
T-4	40.34	55.22	40.43	40.41	2.94
T-5	50.8	29.3	21.89	38.98	2.35
T-6	32.36	51.86	33.9	29.45	2.46

The mean, minimum, maximum, and standard deviation was calculated for the above data. The table and paragraphs below show these results and conclusions about the tasks.

Task 1 (Navigation and Login): The average time for this task is moderate, and

the standard deviation is not very high, which suggests that most teachers were able to perform this task with similar efficiency. The task seems to be well-understood and does not show extreme variability in the time taken, which indicates that the process is straightforward or that the teachers have a similar level of proficiency with such tasks.

Table 2.

Teacher Data Analysis

	Mean sec.	Deviation sec.	Min sec.	Max sec.
Task 1	42.45	9.56	31.94	55.45
Task 2	47.32	10.48	29.3	58.5
Task 3	45	17.13	21.89	70.45
Task 4	48.22	14.73	29.45	69.65

Task 2 (Research Grant Information): This task has a higher mean time and a wide range of times as shown by the standard deviation. It could mean that finding information about the research grant and requesting more information is a bit more complex or less intuitive than the first task. The variability might suggest that the ease of completing this task is more dependent on the individual's familiarity with the website or their understanding of where to find research-related information.

Task 3 (Lecture Download): This task has the highest mean and standard deviation, suggesting that it took the longest time on average and had the greatest variability among the teachers. This could indicate that the process for finding and downloading a lecture is not as straightforward, or that there's a high variance in the navigation skills or familiarity with the class materials among the teachers. Another factor here is that these are all first-time users of the site. In order to complete this particular task, you would need to spend more time reading the cards until you found the

right one.

Task 4 (Setup Manual Download): While the average time for this task is the highest among the four, the standard deviation is lower than that for Task 3 but still considerable. Again, I would attribute this to needing to read the cards on the site until you found the correct one.

These users also gave qualitative feedback as well. Common items are listed in the table below.

Table 3.

Table 3: Teacher Qualitative Feedback.

Positive	Negative
I love the pictures	The navigation bar needs to be bigger.
I like how the software I need is in one place.	The text is kind of small and hard to read.
The site is easy to use	The research page is good but plain
I want this for my class.	What does the game look like?

In conclusion, based on the teachers, developers, and grant authors feedback from scenarios performed and verbal observations the site communicated its intended objectives successfully.

4.5 Improvements / Final product.

A few notable improvements came from the educator study. Five out of six participants said they identified with the term “teacher “more than “educator” and as a result a main navigation heading was changed because of that feedback. Also, a second carousel was added to the front page highlighting more of the project gameplay. Lastly, headings for notebook and classroom were changed to student and lecture materials for clarity.

Below are screenshots of the final site along with descriptions of what, if anything, was improved from functionality testing forward.

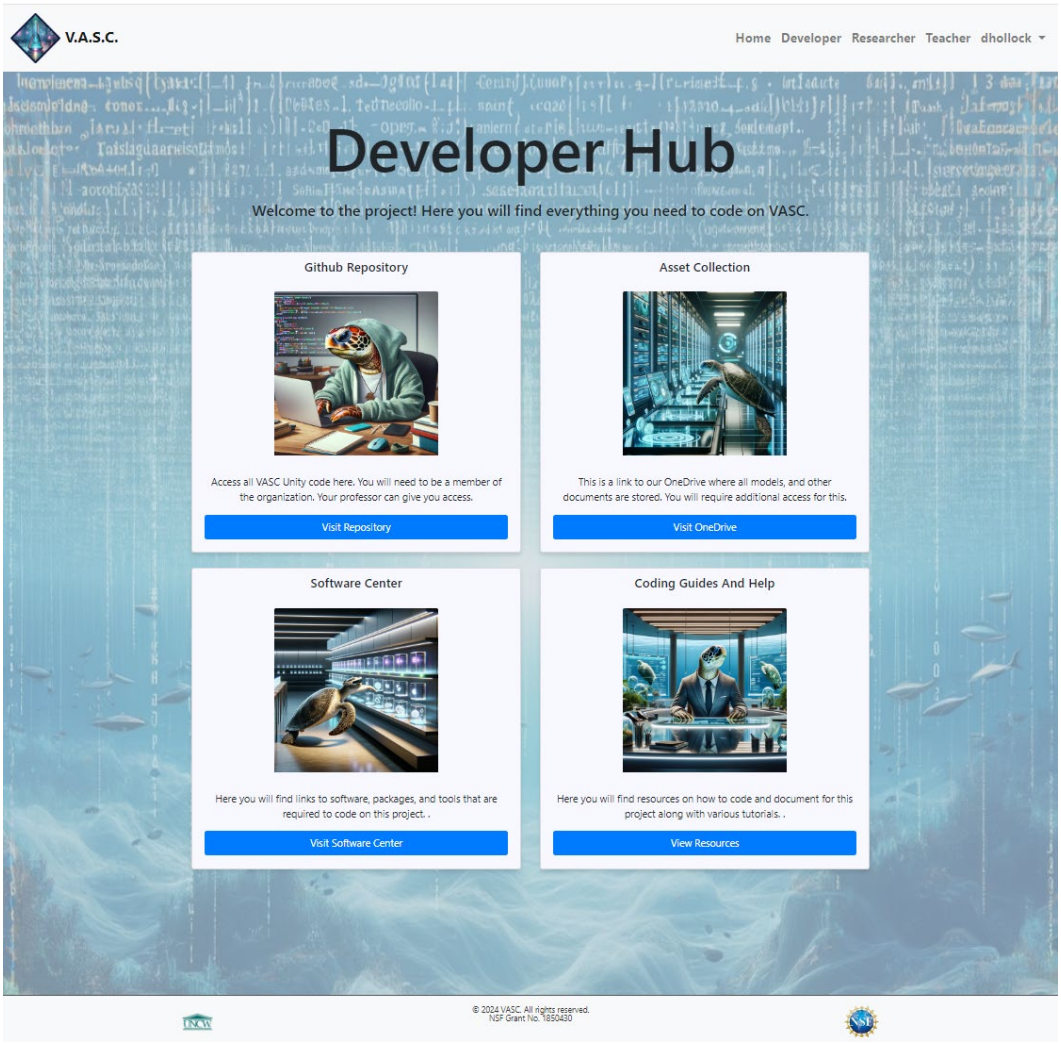

Figure 15: Final Developer Page.

The developer hub houses everything someone needs to code on this project. The main criticisms for this page were the plain background which was changed to this faded underwater code, larger text for headings, and it was suggested that the headings on each card be moved to the top, so it was easier to scan for what the user was looking for.

This is also the section where it was decided for security reasons to lock the assets and code repository behind a second layer of security. The code requires you to be added

to the VASC GitHub and the access to the assets involves being added to the UNCW OneDrive.

Figure 16: Final Teacher Page

This page represented some of the most significant changes implemented from the testing. This section was originally called educator but almost all the participants in the study said they identified more as a teacher. Also, the bottom cards were titled notebook and classroom. When talking with the teachers in the study they felt it was unclear what these headings were for until they explored them further. I decided to change these to student and lecture upon their suggestion. As with the other pages the background was added, and the text changed for easier reading.

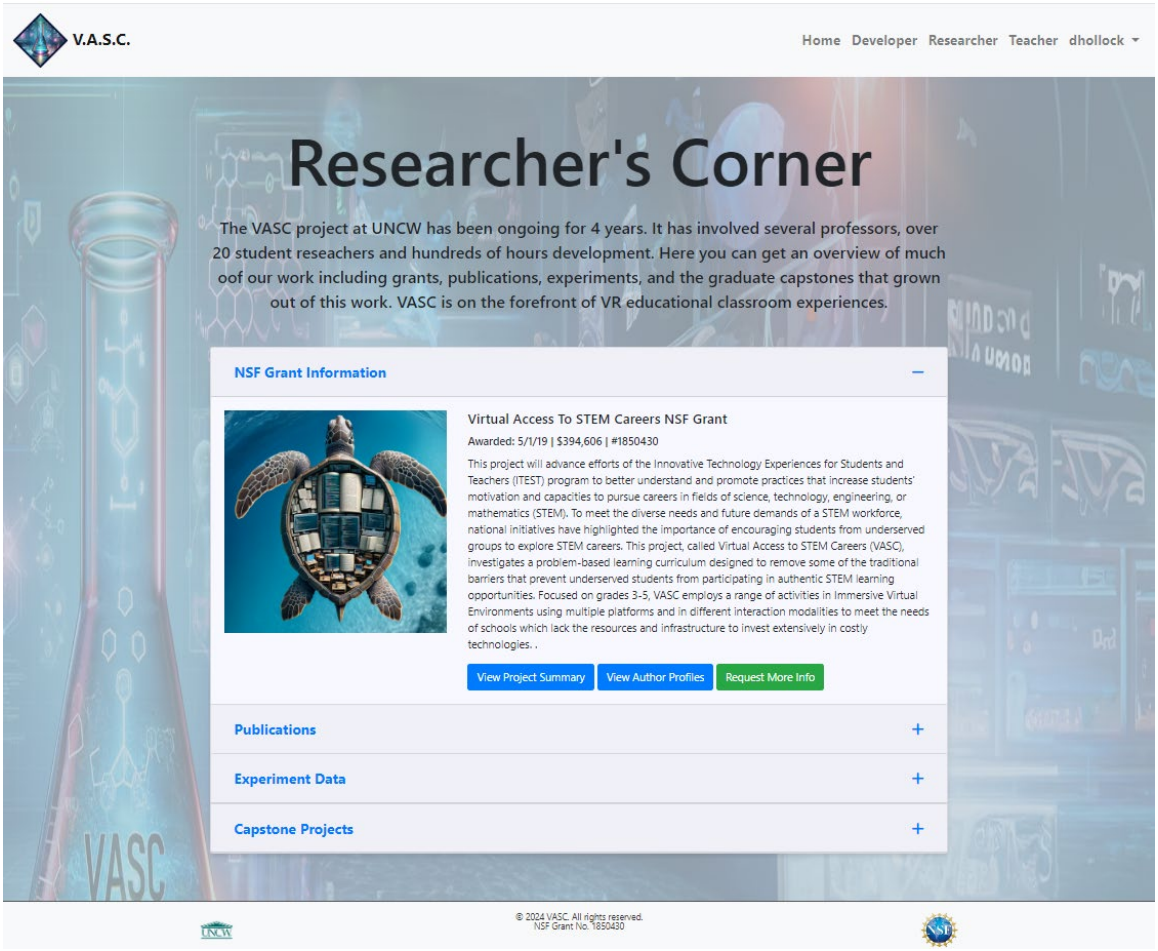

Figure 17. Final Research Page

This page was where the developers and grant authors felt something was missing. The backgrounds on the site were first added here and after the positive feedback I added them to the rest of the site. The accordion headings in addition to the text on this page were made larger.

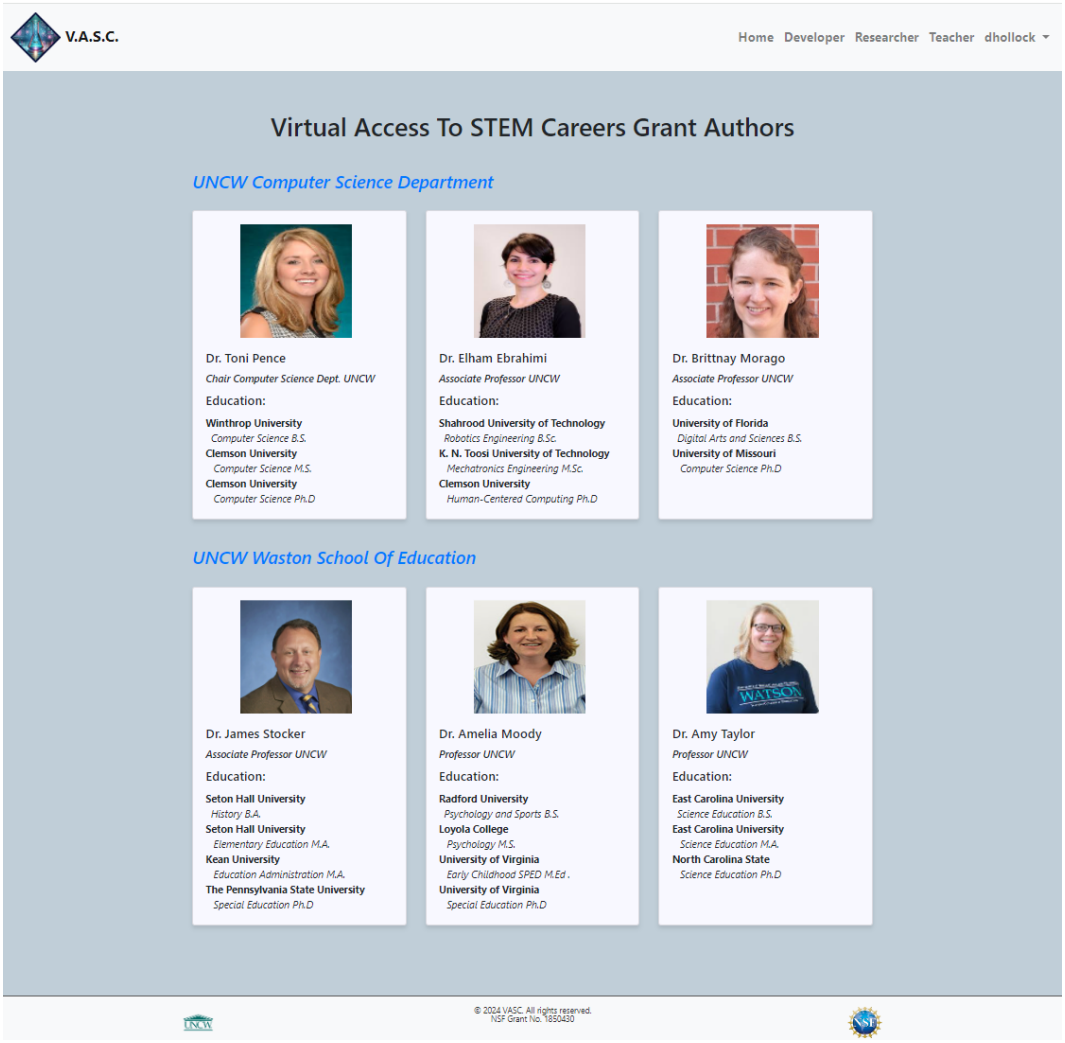

Figure 18. Final Grant Author Page.

This page had just a few changes. The grant authors were organized by their respective departments in the university and a link to their departments for more information.

CHAPTER 5 FINAL THOUGHTS / FUTURE WORKS

5.1 Conclusions and Final Thoughts.

The design and usability study of this web application not only represents a pivotal moment in my pursuit of a master's degree but also shows the possibilities future endeavors might explore. I have had a personal connection to this project for over three years at UNCW. This project is more than just an academic requirement; it is the conclusion for me of a project that I believe in and one that has shaped my education and personal growth.

Each phase of development in this project brought its own set of challenges and learning opportunities. The transition from abstract ideas to a tangible, functional web application was a technical journey that tested and expanded my abilities. It was a process that required not only the application of theoretical knowledge acquired during my studies but also patience, problem-solving skills, and a deep understanding of user-centered design principles.

Throughout this project, one of the most profound revelations was the impact of user interaction on shaping the final product. Features and elements I initially deemed peripheral or minor often turned out to have significant implications for the overall user experience. This underscored the importance of adopting a user-centric approach in web development, where the needs and preferences of the end-user are paramount in guiding design and functionality decisions.

Moreover, the project's evolution through various stages of development highlighted the value of iterative design and the power of feedback. With more time, I would have prioritized even more frequent iterations, allowing for a continuous feedback loop with a consistent group of users. This approach would have facilitated a more

dynamic and responsive development process, enabling the refinement of the application in real-time based on direct user input and experiences.

In addition to technical development, this project served as a platform for professional and personal reflection. It allowed me to evaluate my growth as a developer and scholar, reflecting on how each decision, success, and setback contributed to the final outcome. This introspection revealed the intricate balance between technical proficiency and the softer skills of communication, adaptability, and critical thinking, all of which are essential in the ever-evolving landscape of technology and innovation.

5.2 Future Works

The project's initial scope was ambitious, which, while challenging, has paved the way for future enhancements and expansions. The groundwork laid by this project opens up several avenues for further development:

Marketing and User Engagement: Creating marketing materials, such as walkthroughs and promotional videos, can significantly enhance user engagement and understanding of the application. These materials can be used to illustrate the application's benefits in educational settings, providing a clearer picture of its functionality and impact.

Database Utilization and Research Showcase: The application's existing database, which already collects user data, presents an opportunity to develop a research showcase. This feature could highlight the contributions of past students, offering them a platform to link to their academic or professional work. Furthermore, the collected data could serve as a valuable resource for generating detailed analytics on user demographics and behavior, facilitating a feedback loop that can inform future improvements and adaptations.

SEO and Online Presence: My recent experiences with search engine optimization (SEO) and analytics have underscored the importance of online visibility. Allocating time and resources to enhance the application's metadata and develop a comprehensive SEO strategy could significantly increase its discoverability and user base. By leveraging analytics, we can gain insights into user engagement patterns and tailor the application to better meet the needs of its audience.

Mobile Responsiveness: While the web application has mobile responsiveness more work could be done here with Bootstrap to make the interface cleaner and easier to read on mobile devices, especially phones.

This website will be deployed on the UNCW domain at some point in the future. As I stated earlier in the paper, I chose this particular software stack because it is comprised of programs and languages taught here at the university. This means that a computer science major should be able to maintain and expand the site without difficulty.

The conclusion of this project does not signify an end but rather a stop along the way in a continual journey of learning and exploration. It lays the groundwork for future research and development which hopefully will help in the future success of the VASC project. This undertaking has equipped me with new skills and insights that I can use for future projects. It has given me the confidence and realization that my time spent here at UNCW has given me the foundational knowledge and skills to tackle any task put in front of me.

Figure 19. Project Timeline

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APPENDIX A

PROPOSED SURVEYS

Educator Survey

1. How often do you access educational websites or web applications to retrieve curriculum materials or gain support in your subject area?
    - Multiple times a day
    - Daily
    - Weekly
    - Monthly
    - Rarely

2. On a scale of 1 to 5, how would you rate the overall usability of most curriculum-based websites with which you have interacted?
    1 - Very difficult to use
    2 - Difficult to use
    3 - Neutral
    4 - Easy to use
    5 - Very easy to use.

3. Describe a frustration or problem you have encountered with curriculum-based websites or web applications.

4. How important is it for a curriculum website to have a responsive design that adapts to different devices (e.g., tablets, desktops, mobiles)?
    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important.

5. What feature or tool do you wish was available on websites where you access curriculum resources or subject support?

6. What improvements would enhance your experience when accessing and downloading materials from a curriculum-focused website?

7. How important is offline access or the ability to save materials locally from a curriculum website?
    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important.

8. How intuitive is the navigation on most curriculum-focused websites you have used?
   1 - Not intuitive
   2 - Slightly intuitive
   3 - Moderately intuitive
   4 - Intuitive
   5 - Very intuitive.

9. What type of search functionality do you prefer when looking for specific curriculum materials?
   - Simple keyword search
   - Advanced search with multiple filters (e.g., grade level, topic, type of material)
   - Topic or category browsing
   - A combination of the above
   - Other (please specify): _____

10. Would you find value in a feature that allows you to customize the user interface (e.g., dark mode, font size adjustments)?
    - Definitely valuable
    - Somewhat valuable
    - Neutral
    - Unlikely to use.
    - Not valuable at all

11. What is your preferred method of being notified about updates or new materials on the website?
    - Email notifications
    - In-site notifications or pop-ups
    - Mobile app notifications (if applicable)
    - I would rather check manually when I log in.
    - Other (please specify): _____

12. How crucial is fast load time for pages and downloadable materials on a curriculum-focused website?
    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important.

13. Would a “favorites” or “bookmarking” feature, where you can save and quickly access specific materials, be useful to you?
    - Extremely useful
    - Somewhat useful
    - Neutral
    - Unlikely to use.

- Not useful at all

14. What is your favorite website to use for curriculum materials?

15. Do you have any other suggestions or feedback that could improve your experience with curriculum-focused websites or web applications?

APPENDIX B

Grant Author Survey

1. How often do you access research-related websites or web applications for your work?
    - Multiple times a day
    - Daily
    - Weekly
    - Monthly
    - Rarely

2. On a scale of 1 to 5, how would you rate the overall usability of most research and grant-focused websites you have interacted with?

    1 - Very difficult to use
    2 - Difficult to use
    3 - Neutral
    4 - Easy to use
    5 - Very easy to use

3. What challenges have you faced when using research or grant-related websites or web applications?

4. How important is mobile accessibility for research or grant websites?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

5. What is one feature or tool you wish was available on research-focused websites or platforms for grant authors?

6. How do you prefer to receive updates or notifications about new research publications or grant opportunities?
    - Email alerts
    - In-platform notifications
    - RSS feeds
    - Mobile app notifications (if applicable)
    - Other (please specify): _____

7. On a scale of 1 to 5, how crucial is data privacy, especially when downloading or uploading research papers or grant applications?

1 - Not important
2 - Slightly important
3 - Moderately important
4 - Important
5 - Extremely important

8. Would you find value in a feature that allows for peer reviews or community feedback within the platform?
    - Definitely valuable
    - Somewhat valuable
    - Neutral
    - Unlikely to use.
    - Not valuable at all
9. On a scale of 1 to 5, how crucial is fast access to full-text research papers or grant details on such websites?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

10. On a scale of 1 to 5, how important is a user-friendly interface with clear, organized layouts and intuitive menus?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

11. When faced with technical issues on such platforms, how do you prefer to seek assistance?
    - Live chat support
    - Email support
    - Community forums
    - FAQ sections
    - Other (please specify): _____

12. Would you find value in a feature that allows you to customize the user interface (e.g., dark mode, font size adjustments)?
    - Definitely valuable
    - Somewhat valuable
    - Neutral
    - Unlikely to use.
    - Not valuable at all

13. Do you have any other feedback or features you would like to see on websites or platforms tailored for researchers and grant authors?

APPENDIX C

Developer Survey

1. How often do you access project-related platforms or web applications to retrieve information for your development tasks?
    - Multiple times a day
    - Daily
    - Weekly
    - Monthly
    - Rarely

2. On a scale of 1 to 5, how would you rate the usability of most project information platforms with which you have interacted?

    1 - Very difficult to use
    2 - Difficult to use
    3 - Neutral
    4 - Easy to use
    5 - Very easy to use

3. Which feature is most important to you when accessing project information platforms?
    - Real-time project updates
    - Clear task assignments and responsibilities
    - Accessible documentation and resources
    - Comprehensive project timelines and milestones
    - Integration with communication tools
    - Other (please specify): _____

4. Describe a challenge you have faced when trying to access or understand project information on a platform.

5. How important is it for you to have a feature that allows easy documentation of your work progress?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

6. What tool or feature do you find most effective for documenting your work on development projects?

7. How do you prefer to communicate with project managers, team leads, or other team members?

    - Direct messaging within the platform
    - Dedicated communication channels (e.g., Slack, Teams)
    - Email
    - Scheduled meetings (virtual or physical)
    - Other (please specify): _____

8. How would you rate the importance of clear communication guidelines within a project?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

9. Do you find value in having a centralized dashboard that highlights all project-related information, tasks, and updates?
    - Essential for my workflow
    - Useful, but not essential
    - Neutral
    - I prefer separate tools or platforms.

10. How do you ensure that the documentation you create is accessible and understandable by other team members?

11. What is your preference for project information storage?
    - Cloud-based solutions
    - Local storage solutions
    - A combination of both
    - No preference

12. How do you feel about having a feature that allows for setting personal reminders or to-dos within the project platform?
    - Very useful
    - Somewhat useful
    - Neutral
    - Not useful

13. Would you prefer a platform that offers customizable views or layouts such as dark mode?
    - Strongly prefer.
    - Somewhat prefer.
    - Neutral
    - Prefer standardized views for consistency.

14. How do you manage or keep track of any blockers or challenges faced during the development process?

15. On a scale of 1 to 5, how important is it for the platform to facilitate smooth handoffs between distinct roles or stages in the project?

    1 - Not important
    2 - Slightly important
    3 - Moderately important
    4 - Important
    5 - Extremely important

16. Do you have other feedback or suggestions for features that would enhance a developer's experience in accessing and interacting with project information?