For Youth For Life: 4-H Digital Badges: A Collaborative Tool to Support Informal Learning

by

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Abstract

The intent of FYFL (For Youth For Life) application is to provide an easy to use, cost effective and scalable collaborative system in order to facilitate learning and sharing best practices across communities and institution in line with Computer Supportive Collaborative Work. The proposed research will be designed, developed as a secure collaborative tool that caters issues related to usability and managing groups of the communities of practice to promote motivation for informal learning. The study performs empirical experiment to support adopting For Youth For Life Digital Badges as a unique solution for sharing best practices in the 4-H world. 4-H Digital Badges is an application described as an online skill, quality and accomplishment recognition and validation system. The system supports different populations of users namely youth members, group leaders and different level of administrators (every level having different privileges explained later). The admins utilize this system to create and manage badges, which will be earned by the youth learners by doing substantial amount of work related to that badge. The usability tests and performance results exhibit that the system is intuitive, easy to navigate, and is designed with unconcealed user interface that results in promoting efficient learning and collaboration. The usability tests and performance results were contributory in gauging the efficacy and receptiveness of the designed web-based tool.

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Pride Praise and Perfection belong to the almighty alone. So, first of all I would like to offer my heartfelt salutation to the Supreme Being for the physical and mental strength bestowed upon me and in whose faith, I was able to complete this task.

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Chapter 1

Introduction

1.1 Motivation

For centuries, education has taken place in a single form: where a teacher is teaching a group of students in a classroom, making them learn important concepts of Mathematics, Science etc. Often student read books and gives exams and everything is conducted through a physical medium. But as time is advancing the whole paradigm is shifting to a digital age. Now learners can take online classes, there level of understanding can be gauged using online assessments, they can access the material just when ever they want and it is cost effective too. The idea of incorporating E-learning is not to replace traditional methods, but it's main objective is to enhance it's efficiency thereby making it more cost effective and improving it's quality. It can enhance learning well beyond the classroom. Education software is expensive, but this expense is no gauge of how effective they are, institutions and various organizations are hesitant in investing into them. In order to help this situation, there is a great need of a low cost Learning Management System helping student to gain maximum out of it. To that end, this research focuses on creating an environment (4-H Digital Badges) which is intended to encourage social computing among 4-H Kids and 4-H club members who will collaborate, share and re-use best practices.

1.2 Purpose of the Research

The main goal of this research is to design and develop a novel collaborative system, which can promote learning and incur motivation among communities of practices members to share best practices at low cost. This study has identified K-12 students and 4-H club

members as the initial group, which has the potential benefit from the system. We are proposing to create an application, which does the following: (1) provides a medium where members of community can share and impart knowledge to others. (2) provides a medium where member of the system can collaborate more freely in order to share knowledge, and best practices.

1.3 Approaches to the Research

The study will focus on designing and developing the 4-H digital badges system and thereby proving is worthiness by pilot testing amongst our potential target audience. In the Phase I of this research includes gathering of initial requirement by the client (4-H) followed by analysis of the prevalent system and usability inspections and thereby coming up with the design and architecture of the system. Phase II of the research deals with the development of the system, followed by field and pilot test of the application developed and thereby proving the existence of the system. Phase IV consists of the design of the next iteration of the system, researching on possible security threats and developing solutions in order to deal with the same.

Chapter 2

Literature Review

2.1 Computer Supportive Collaborative Work (CSCW)

2.1.1 What is CSCW?

CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services, and techniques [20]. CSCW provides cooperation and brings together many disciplines together, like theorists, social psychologists etc. Though the field is multi-disciplinary, it is focused on designing or re-engineering computer-based technology products to support a specific group's work [6] [5]. The design of CSCW technology is altered to specific characteristics, which are unique to a specific user group based on the understanding of group's work and practices. However, there is a great number of increase of group if users that use technological innovations for unexpected activities [21].

2.1.2 CSCW to Cater Communities

The term CSCW was first coined by Irene Grief and Paul M. Cashman in 1984, at a workshop attended by individuals interested in using technology to support people in their work [11]. At about the same time Dr. Charles Findley presented the concept of Collaborative Learning-Work; "how collaborative activities and their coordination can be supported by means of computer system" [11]. There are three core dimensions of cooperative work that have been discovered over the years:

Awareness: Individuals working together need to gain some level of share knowledge about each other's activity [10].

Articulation: Refers to cooperating individuals must somehow be able to partition work into units, divide it amongst themselves, and after the work is performed, reintegrate it[14] [12].

Appropriation (or tailorability): deals with how an individual or group adapts a technology to their own particular situation; the technology may be appropriated in a manner completely unintended by the designers [1].

In order to address the social - technology divide Morgan Kaufmann uses a Time/Space matrix and divides CSCWs into group; same time —same place, different times - same place, different time - different space and different time - different space. The matrix is intended to be a replica of real life social situations that CSCWs designers will have to address when creating/refining CSCWs. The Time/Space Groupware Matrix shown below courtesy of Morgan Kaufmann publishers outlines the different ways people collaborate [17]. Both time and space facets are bipolar (i.e. same time or different time and same lace different place perspective). Thus the time space groupware matrix has online communities divided into four categories:

Same Time, Same Place — Synchronous Co-located: Characterized with face to face interactions in decision rooms, single displays, groupware, shared table, wall displays, room ware etc. [17]..

Same Place, Different Time — Asynchronous: A major collaboration between a group working on continuous tasks through tea rooms, large public displays, shift work groupware, project management etc.[17]..

Different Place, Same Time — Asynchronous Remote: Remote interactions accomplished through video conferencing, instant messaging, charts/MUDs/virtual worlds, shared screens, multi-user editors etc. [17]..

Different Place, Same Time — Asynchronous-Remote: Communication, coordination, e-mail, bulletin boards, blogs, asynchronous conferencing, group calendars, workflow, version control, wikis [17]. The CSCW paradigm provides a framework of what we know can

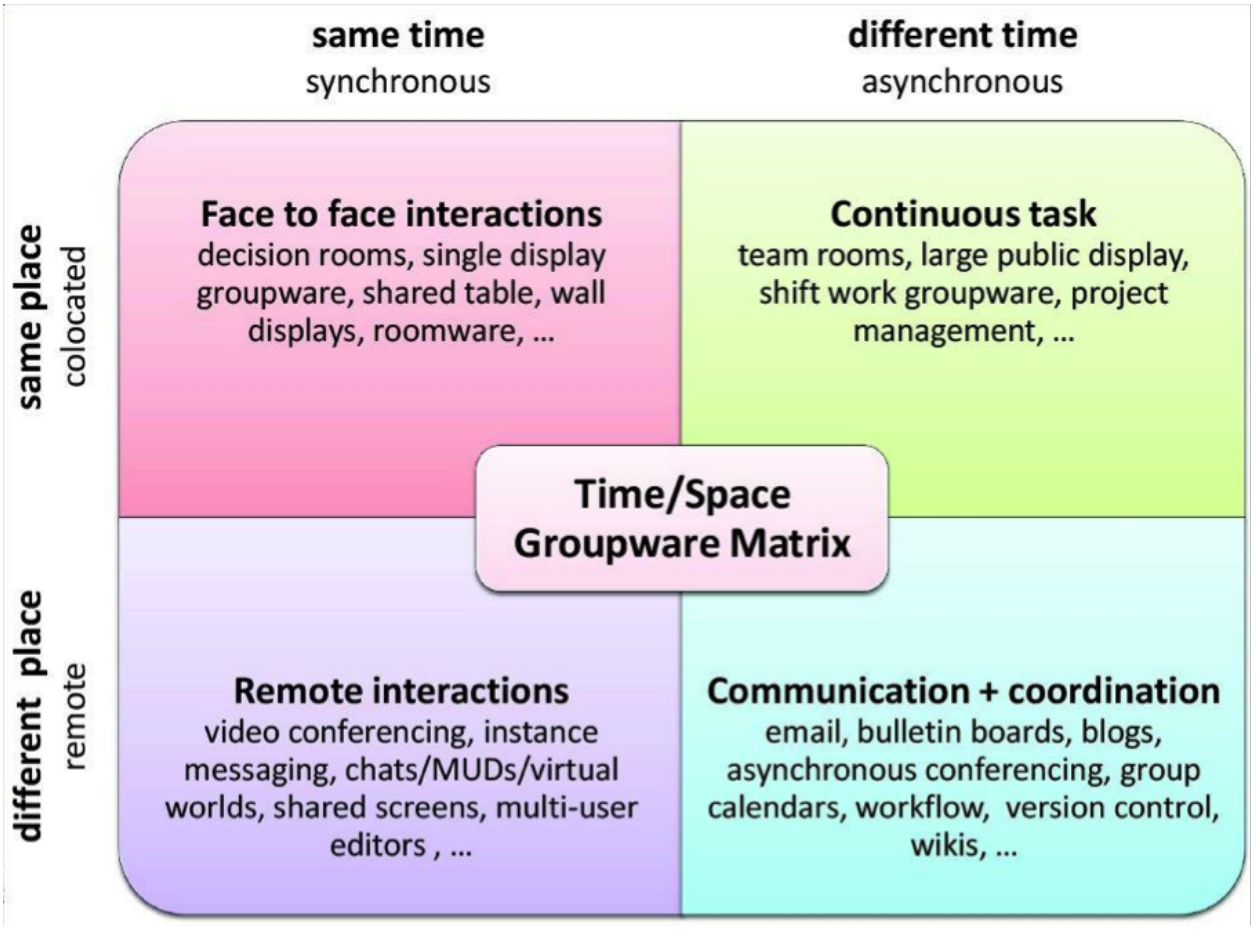


Figure 2.1: CSCW Matrix. (Source: Johansen, R. 1988 "Groupware: Computer Support for Business Teams" The Free Press.)

support socially but the social technical mapping still remains the primary problem. Many of the researchers in this area are looking for way to bridge the disparity between the social need and capacity to support the need technically from a computer science perspective [2]. Many social forums have been implemented to serve communities. These forums are intended meeting spot for individuals to gather and socialize. In academic world, systems are utilized as a pedagogical agent to enhance teaching and sharing knowledge (e.g. blackboard, Moodle etc.) [15]. Our goal is to leverage the social in providing an application where members of the communities will spend time and contribute to the knowledge of peers, and thereby recognizing skills.

2.2 Web-based learning

2.2.1 Computer-supportive collaborative learning (CSCL)

Computer supportive collaborative learning (CSCL) is a relatively new educational paradigm within collaborative learning, which uses technology in learning environment to help mediate and support interactions in a collaborative learning context. CSCL systems use technology to control and monitor interactions, to regulate tasks, rules, and roles, and to mediate the acquisition of new knowledge[15]. Researchers and practitioners in various fields, including computer engineering, sociology, have begun to investigate social computing and CSCL.

2.2.2 Web-based Learning Systems

Learning management systems is a context that gives learning through collaboration a specific meaning. In this context, collaborative learning refers to a collection of tools, which provide assistance to the learners, in order to gain and share knowledge. Such tools include virtual classrooms, chats, discussion threads, and application sharing. Notable learning management systems include Blackboard, Canvas, Moodle, Joomla, etc.

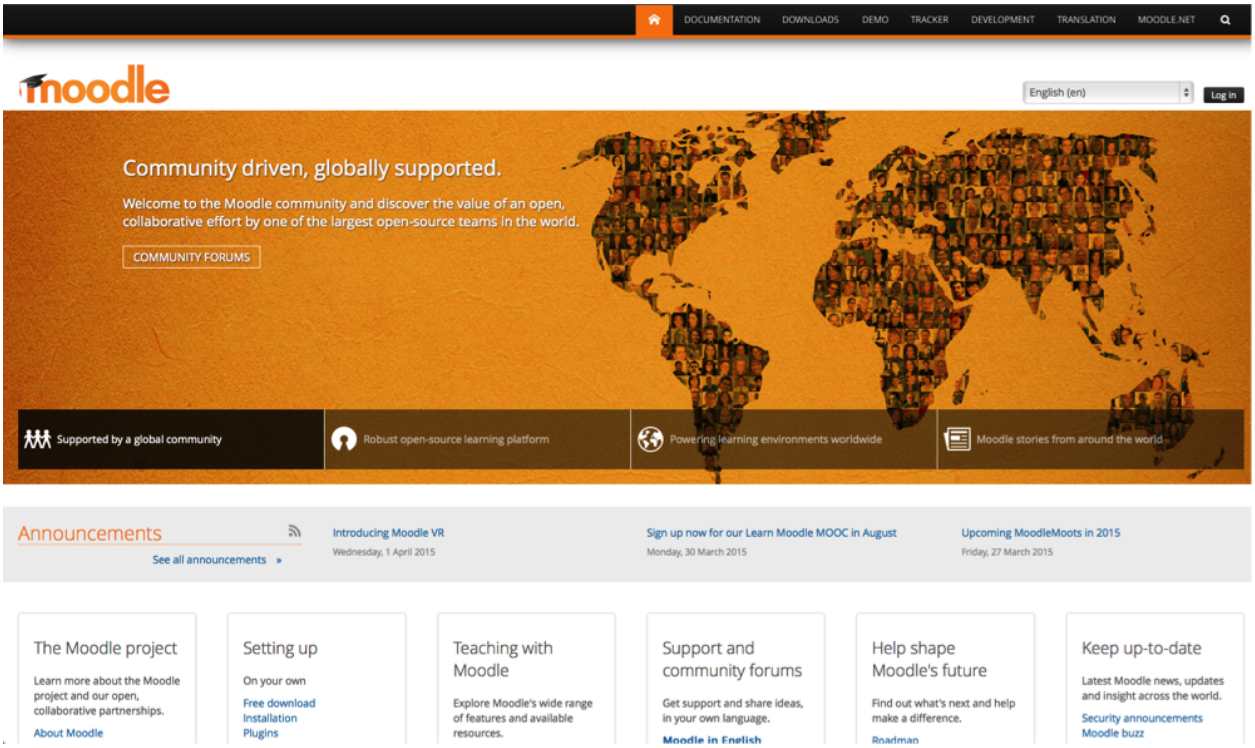


Figure 2.2: Moodle

2.2.3 Moodle

Moodle is a software package for producing Internet-based courses and websites. It is a global development project designed to support a social constructionist framework of education [7]. Moodle is provided freely as Open Source software (under the GNU Public License). Basically this means Moodle is copyrighted, but users are allowed to copy, use and modify Moodle provided that you agree to provide the source to others, not modify or remove the original license and copyrights, and apply this same license to any derivative work. Other requirements are to read the license for full details and contact the copyright holder directly if you have any questions [7].. Moodle can be installed on any computer that can run PHP and can support an SQL type database (for example MySQL). It can be run on Windows and Mac operating systems and many flavors of Linux (for example Red Hat or Debian GNU). There are many knowledgeable Moodle Partners to assist you, even host your Moodle site [7]..

The word Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment and is useful to programmers and educators with advanced computer skills. It also means a process of twisting through a place slowly without any resistance to the tasks that present themselves. This description applies both to the way Moodle was developed, and to the way a student or teacher might approach studying or teaching an online course [13]. In order to provide an online learning tool and a skill recognition method, digital badges became an answer to all the questions.

2.3 Digital badges

Digital badges are validated indicators of accomplishment, skill, quality or interest that can be earned in various learning environments[7].

2.3.1 Development of Badges

Traditional physical badges have been used for many years by various organizations such as United States Army to give members a physical emblem to display various achievements [8]. While physical badges have been in existence for a while, the concept of digital badges is fairly nubile, badges have been issued by organizations such as Mozilla, Huffington post etc. to reward accomplishments for certain tasks.

2.3.2 Motivation to Participate

One of the ways in which badges are often used is to encourage participation by recognizing the participants. Motivation is often one of the major reasons designers decide to employ badges. Participation is encouraged because badges offer a new pathway of lifelong learning separate from the traditional, formalized academic pathway. Badges highlight and recognize skills and knowledge that come from personal initiative and investigation[9].

2.3.3 Motivation to Collaborate

Badges "enhance identity and reputation, raising profiles within learning communities and among peers by aggregating identities across other communities and build community and social capital by helping learners find peers and mentors with similar interests. Community badges help formalize camaraderie, team synthesis, and communities of practice"[16]. Badges quantify the soft skills of teamwork that are pivotal to success in many professions today.

2.3.4 Recognition and Assessment

They can also function as transformative assessment [19]. that shape existing learning or allow new ones to be created [3] [4]. Digital badges might be particularly useful as part of a formative assessment process, providing constant feedback and tracking of what has been learned and what the next step might be. Massive online open courses (MOOCs) and e-assessments [23], Mora, M.C. et al. (2012), p. 734 can be used to deliver content at scale, while providing structured points for formative assessment, connections to learning communities, and new possibilities for strengthening individual agency in the learning process, Hickey, D. (2012). Such environments might leverage self- and peer-assessment, again as part of formative processes.

2.3.5 Current Badges Systems

2.3.5.1 Mozilla Open Badges

Open Badges take that concept one step further, and allows you to verify your skills, interests and achievements through credible organizations and attaches that information to the badge image file, hard-coding the metadata for future access and review. Because the system is based on an open standard, earners can combine multiple badges from different issuers to tell the complete story of their achievements – both online and off. Badges can

be displayed wherever earners want them on the web, and share them for employment, education or lifelong learning. Open Badges are:

Free and open: Mozilla Open Badges is not proprietary. It's free software and an open technical standard any organization can use to create, issue and verify digital badges.

Transferable: Collect badges from multiple sources, online and off, into a single backpack. Then display your skills and achievements on social networking profiles, job sites, websites and more.

Stackable: Whether they're issued by one organization or many, badges can build upon each other and be stacked to tell the full story of your skills and achievements.

Evidence-based: Open Badges are information-rich. Each badge has important metadata which is hard-coded into the badge image file itself that links back to the issuer, criteria and verifying evidence.

Open Badges make it easy to:

- Get recognition for the things you learn;
- Give recognition for the things you teach;
- Verify skills;
- Display your verified badges across the web.

Figure 2.3: Mozilla Open Badges

2.4 Usibility

Usability is considered one if the most important factor web application, along with reliability and security. If the application does not have a good usability, it's significance can be deprecated. An applications's usability is not just good user interface design. As the visual appeal of a web application is important, the fundamental structure and programming can also contribute to "good usability" [25].

Usability can be defined as the "the extent to which a product can be used by certain users in a specific context of use to achieve the specified objectives effectively, and efficiently and satisfactorily". This define nation, which is provided by the international standard ISO/ IEC 9241-41 describes the most important issues/ pre-requisites to be taken into consideration when designing an application: Who are the users of the application? what are the objectives of the application? In which context the application is used? Can the objectives be achieved efficiently, effectively, and satisfactorily? which in turn make the application easy to use and

without any difficulty, resulting in a positive attitude of the user. As our target audience is teens, we will be focussing on teenage usability and factors affecting the same.

2.4.1 Teenage Usibility

Our target audience is teens, we will be focussing on teenage usability and factors affecting the same. Teens are wired. Technology is so integrated with teenagers? lives that creating useful and usable websites for them is more critical than ever. To succeed in a world where the next best thing is a click away and text message interruptions are the rule, not the exception, website creators must clearly understand what teens want and how to keep them on a site [24].

Teens are becoming more successful at navigating websites and finding what they need. The success rate for teens has improved 16 percent dusting 8 years between the old and new studies, for an improvement rate of 2 percentage point points per year. This is slightly better than the improvement rate of 1.7 percent per year for adults using websites over the past decades [24].

Though with this improvement, teens bad user habits still remains the same. teens performs worse than the adults for three reasons.

- Insufficient reading skills
- Less significant research strategies
- Dramatically lower levels of patience in order to improve an applications usability where target audience is teens, all the factors listed above must be considered.

Following guidelines/factors should be the basis of development when designing an application whose target audience is mostly teens.

Write Well: Write for impatient users. Nothing deters younger audiences more than a cluttered screen full of text. Teens can become bored, distracted, and frustrated.

Make it snappy: A slow-loading website is a deal-breaker, as younger audience do not have patience.

Avoid boring content and entertainment overload: Teens do not want to be bored and contrary to belief, they like interaction, but do not like too much of it.

Use Proper tone: Don't sound condescending or child like.

Facilitate social communication, but don?t force it. Support social communication, but allow teens to be in control of their social awareness.

Design for poor ergonomics: Design to fit teen?s use of portable devices with small screens to prevent fatigue and errors.

Having cool stuff—"The Cool Wall" study (Fitton et al, 2012) provided insignias into what things (e.g., iPhone, sports car, cat, and books) teenagers categorize as cool or uncool to investigate which things/items fall into having cool stuff, doing cool things, or being cool. The items with the highest score fell into the ?having cool stuff? category, suggesting ?possessions are extremely important to teenagers when deciding what is cool more so than doing cool things.? In addition, the authors used their findings to further categorized the items as rebellious, anti-social, retro, authentic, rich, and innovative (unusual) for use in their future research. All the dimensions considered for our user experience are summarized in the table below.

Readability	• Don't use any tiny fonts • Reading level should be should be 6th grade or lower • Write Well – teens don't like to read a lot on the web. • Teens are impatient users.	Aesthetically pleasing presentation
Simple Content Aesthetics	• Informational sites should look simple and polished. • Avoid Clutter – display content in small meaningful chunks with white spaces. • Avoid boring content and entertainment overload, do not overuse or include pointless interaction and multimedia.	Aesthetically pleasing presentation
Navigation	• Minimize the need to hunt for things to click, tabbed browsing, and scrolling.	Simple navigation and controls
Searching	• Avoid searching	Simple navigation and controls
Interaction	Ideal interactive features include quizzes, forms for feedback or asking questions, online voting, games, features for sharing pictures or stories, message boards, forums for offering and receiving advice, and features for creating a website or adding content.	Support learner motivation and creativity
User Control	Facilitate sharing, but don't force it. • User want to control what and how they fey share information for social media.	Good Utility
Content	Don't talk down to teens. • Don't appear condescending or baby like.	Aesthetically pleasing presentation
Content	Supplement content with stories, images, or examples from other teens.	Support learner motivation and creativity
Content	Avoid Boring Content and Entertainment Overload: • Don't overuse or include pointless interaction and multimedia. • Idea interactive features include quizzes, forms for feedback or asking questions, online voting games, features for sharing pictures or stories.	Support learner motivation and creativity
User Characteristics	• Generally have a specific goal-tasks, entertainment, etc. • Age-Specific	Overall Satisfaction
Technical	• Site should be load quickly • Design for small screens and poor ergonomics	Efficient to use

Figure 2.4: User Experience and usability Guidelines for Teenagers: Ages (13-17 and (3-12))

Chapter 3

Statement of the Problem

This chapter broaches the research problem, hypothesis and the research questions of the study conducted. Furthermore, it elaborates the characteristics of the empirical/experimental research that are common to all studies. First, the introduction of the research problem will be done, followed by the arising queries; the hypothesis addressed by the user study. In this project, an inquisition on the study questions and hypothesis will be conducted. Furthermore, benefits for the 4-H Digital Badges System, and design to promote ease of use and features that are supportive for the novice learner will be discussed. This includes the methodology for the study "Paper Badges" as a community of practice tool and methodology and usability of 4-H Digital badges.

A complete analysis of a comprehensive study between the traditional methods, Drupal System and 4-H Digital Badge System will be discussed and be part of this research report. For the 4-H youth audience and the Adults in the system, in order to use a virtual space efficiently and effectively in accomplishing the goals of learning (utilized by the youth), and sharing the knowledge (Adults), our aim is to empower 4-H users with software tools that suit their needs. In the current 4-H world youth, adults have no time, desire or impetus to learn new tools let alone develop and refine tools that serve their community. Thus, there is a need to develop a product that not only suffices the need of both end of the community (namely the adults and the learners), to promote learning and share and re-using best practices. An easy way to achieve the above said goal is using the currently operational Badge System tailor it and evaluate it with users, (e.g. earning of badges etc.). However, these applications are aimed at serving professional and general audience with significant experience in the systems and software. A large number of applications have a very little

evaluation of the user experience with the novice audience. In this study, we will focus on communities of practice i.e. 4-H youth and 4-H adults, in which there is a high probability that the person is novice computer user.

This research focuses on 4-H members as a community of practices to understand the 4-H Digital Badges and to share best practices and build a new application that suffices the above-mentioned needs and evaluate the effectiveness of the tool in comparison with the traditional methods and the applications, which are currently in existence.

There are many empirical studies supporting learners' collaboration and sharing best practices in virtual space[20][6]. However, a lot of studies have focused in higher education support content managers like Moodle, Canvas, Open Badges. These support both learners and adults in the learning process[18][14]. Despite number of support collaborations available in the current world, there are large number of applications, which don't encourage sharing of best practices among the 4-H Learners and Adults. The main focus of this study is to provide a closed, private and secure environment, thereby maintaining the cyber trust. The main purpose of this research is to develop an intuitive, easy to use and robust application which provide the provision of sharing digital credentials to support the 4-H community and to motivate learning with incentives to continue this practice through leader secured social networking, which thereby is enough for students, teachers, and groups that might not have a lot of computer knowledge but will be able to intuitively utilize the environment with little or no training at all.

3.1 Research Approach

There are several goals to this study to name a few are:

(a) Design and Develop an efficient tool to facilitate informal learning and sharing best practices for Community of Practices utilizing an expert panel inspection.

(b) Encourage novice learner (Kids) to move towards technological world in comparison with the traditional methods.

(c) Develop tutorials to increase knowledge about the system.

(d) Conduct usability and acceptance test within a group to further improve the system.

(e) Develop a secure system which can easily resist possible attacks like SQL injection, Cross side scripting (XSS) etc.

The principal target of this study is to embolden and to stimulate informal learning through 4-H Digital Badges through collaboration among groups of community of practice. Below are different phases in which the whole research can be granulated.

3.1.1 Phase I: Requirements

Our 4-H partners have been utilizing paper methods since its inception. The process of earning badges, gives a user an incentive to give them a sense notable accomplishment and as a means of social competition and interaction as they share the badges they have earning. This motivation drives the 4-H badging system.

3.1.2 Phase II:Prototyping

Our process is iterative design and development. After the completion of Phase I, we implemented Phase II using thorough inspections and scenarios based techniques. After the completion of Phase II implementation, we also studied the effect of this new implementation through particular design and based on iterative design and development, results we created the results lead to follow an iterative design and development work, which became phase II.

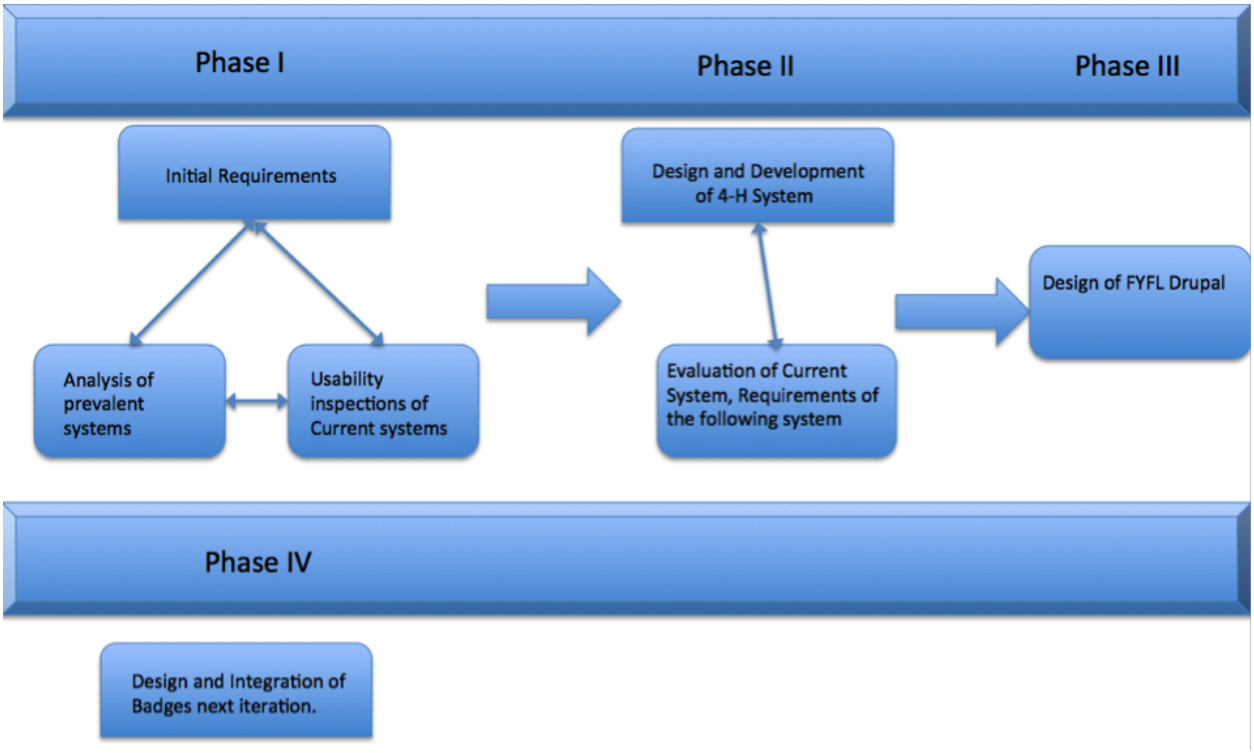


Figure 3.1: Phases

3.1.3 Phase III: 4-H Digital Badges (A Drupal Version)

Based on Task-artifact cycle, 4-H Digital Badges a Drupal version came into existence. Complete design of the system was figured out and implementation of the system was outsourced.

3.1.4 Phase IV: Evaluation of Current System and Designing new Version

Once a comprehensive analysis and expert opinions were done on the product which was the result of phase II which included comparative expert usability inspection, expert opinions etc., designing and development of the newest version of 4-H Digital Badges was started.

3.2 Research Question

This research will provide an efficient and elegant mechanism for assessing and credentialing learning, and is managed online. Digital Badges will be designed to make visible and validated learning in both formal and informal settings, and hold the potential to help transform where and how learning is valued. Along with this, following questions will be investigated:

1. Can informal learning be successfully supported within community of practice via the concept of Digital Badges?

2. Can a user perception about usability of online tools like 4-H Digital Badges affect adoption of a cyber tool if issues of technophobia, computer literacy etc. are not properly handled?

3. Can the usability of a tool affect the motivation of learners and adults in sharing best practices?

4. Can a system be successfully designed and supported which will eventually profess and sustain groups in a virtual world. A system that supports 4-H as an online community to share badges as accomplishments that provides secure social networking for K-12 Children?

5. Can a system be developed which easily resists attacks like SQL injections, XSS etc. and can easily pass the penetration testing?

The prerequisite for the model is that the environment must follow security metrics in order to protect 4-H children and learners as a community of practices from unsolicited contacts while in the process of learning, sharing and re-use of already accepted and developed practices among learners. They should be secure because of the core requirement of COPA compliance.

After the system is fully developed, surveys based on usability and learnability of our application will be conducted.

3.3 Hypothesis

For the 4-H adults and kids to collaborate successfully in a virtual world, they must share knowledge and information. The 4-H Digital Badges environment provides a framework for the kids to imbibe that knowledge under the supervision of their respective adults, as adults are the one who are creating and monitoring learning. In order to validate the systems intuitiveness, we conducted a series of participatory design studies; qualitative evaluation, and usability analysis and data collection was done by the means of different surveys (i.e. task analysis surveys on how easy it is to attempt the quizzes and earning the badges were performed.)

With the use of examples templates to create successful best practices, users will rely on these templates to accomplish trivial tasks, which basically result in sharing best practices just by clicking images on the screen etc. The empirical study will focus on the usability of the tool, which will basically encompass various potential user groups with an emphasis on 4-H kids and group administrators.

This research addresses six-research question listed above that leverage the hypotheses that were tested at the end of the study. The empirical study compares the traditional method and the virtual community of practice methods. It will examine the usability, trust, and analysis of the user interface by experts and kids from different states, which are part of the 4-H World.

3.3.1 Hypotheses I

(I) $H1_A$: There is difference in magnitude of motivation for learners when using 4-H Digital Badges as compared to traditional environments (e.g. Online vs. Paper based).

(II) $H1_0$: There is no difference in magnitude of motivation for learners when using 4-H Digital Badges as compared to traditional environments(e.g. Online vs. Paper based).

3.3.2 Hypotheses II

(I) $H2_0$: There is no difference in misconceptions (like technophobia etc.) that learners have when using 4-H Digital Badges compared to traditional environments.

(II) $H2_A$: There is a difference in misconceptions (technophobia etc.) that learners have when using 4-H Digital Badges compared to traditional environments.

3.3.3 Hypotheses III

(I) $H3_A$: There is no difference in users' preference when using aesthetically improved site compared to original site.

(II) $H3_0$: There is a difference in users' preference when using aesthetically improved site compared to original site.

3.3.4 Hypotheses IV

(I) $H4_A$: The system is secure against possible attacks like SQL injection, cross side scripting etc.

(II) $H4_0$: The system is not secure against possible attacks like SQL injection, cross side scripting etc.

3.3.5 Hypotheses V

(I) $H5_A$: The system is faster in terms of performance as compared to the preexisting Drupal system.

(II) $H5_0$: The system is not faster in terms of performance as compared to the preexisting Drupal system.

3.4 Experimental Procedure and Tasks

The 4-H digital badges project examined the feasibility of establishing five badges based on educational resources in robotics. The criterion developed to earn a badge includes:

1. 21st Century Workplace skills,
2. Science, engineering, and technology (SET) abilities,
3. Science knowledge and
4. Performance on key learning activities.

To measure youth performance a 22-item self-reflective survey was developed using a 4-point Likert type scale for each badge covering the areas previously mentioned (see table 1).
To determine the usability of the system several pilot and field tests were done with youth to determine if: a) The requirements to earn the badges were in-line with the badges prestige, b) Digital badges were a useful extension of the 4-H recognition model, c) Educators and volunteers could determine if the evidence provided by youth met the threshold for issuance of a badge. d) Application was pleasing as far as aesthetics are concerned. e) Easy to navigate around the site. f) The information on the site was accurate.

In the first piloting phase the 22-item survey instrument was field tested with 30 youth ranging in age from 9 to 15 in two US states. In addition, 15 adult facilitators also took part in the piloting of the instrument. A field/website usability test was conducted in two other states with 24 youth ages 10 to 18 to examine functions of the 4-H badge site including user registration and issuance procedures for youth and adults. A survey was developed to measure perceived usability, appearance, and requirements to earn badges using 7-point Likert-type scales. Two questions asked youth to give the site an overall rating from 1 to 10 with 1 being low and 10 high. The surfer was followed by another test consisting of 10 adult facilitators. Results of the surveys will be discussed in detail in following chapters.

Chapter 4

Implementation and Procedure

This chapter deals with the details of the implementation and refined requirements for the development of 4-H Digital Badges after the analysis done on the basis of initial requirements. It also includes the details of Phase I of this research, which is basically gathering the core and functional requirements, and thereby refining them to come to a conclusion. Along with this detailed overview of the following phases like the design and development of the system, designing the architecture of 4-H Drupal system, and development and integration of the latest iteration will be discussed. The implementation has been identified with UML diagrams as an object oriented design standard to capture requirements. Furthermore the chapter describes the basic frameworks used and languages used to develop the system followed by Cross site scripting and SQL injection definitions and the test scripts to test whether the system is able to deals with all these issues or not. Afterwards system describes all the encryption strategies done in order to protect the system from possible attacks. The chapter concludes by the outlining of the use case diagrams, which gives us clear picture of the system requirements. The results, which basically form the outcome of the requirements in this chapter, will be discussed in the next chapter.

4.1 Detailed Overview

4-H is a youth organization and is administered by USDA, has the main mission of "engaging youth to reach their fullest potential while advancing the field of youth development" is our partner in this project. They have been utilizing paper-based methods since it came into existence.

Our 4-H partners have been utilizing paper methods since its inception. The process of

earning badges, gives a user an incentive to give them a sense notable accomplishment and as a means of social competition and interaction as they share the badges they have earning. This motivation drives the 4H badging system.

4.1.1 4-H Digital Badges System Requirements

The main goal of this research as stated in the statements purpose is to develop a system, which will support the members of community of practice to informal learning among peers and learners. The system incorporates an environment to create Digital Badges, attempt the quizzes for corresponding five badges currently in the system, which basically keeps an eye on enhancing efficiency of informal learning, evaluation those responses, which is done by facilitators and sharing those earned badges among the system. In phase I of this project, we have used the refined requirements to create a high level design using the case activity diagrams. During the prototype development, we continually and repetitively conducted informal usability evaluations done by the experts, which will be furthermore used to improve systems functionality and its UI.

The key task for a novice learner is to go through the whole process of earning badges, and the key task for facilitators is to monitor and manage learners. To be successful in this endeavor, the system provides an intuitive walkthrough. Following are the basic requirements of the system followed by the core requirement which concludes the overview of our phase I.

4.1.2 Functional Requirements

1. The application must be web-based.

2. The application must be engaging, in the sense that the interface should be attractive and exciting for our target group.

3. The application must be interactive, meaning that the user is able to interact and the application provides feedback based upon the user interaction.

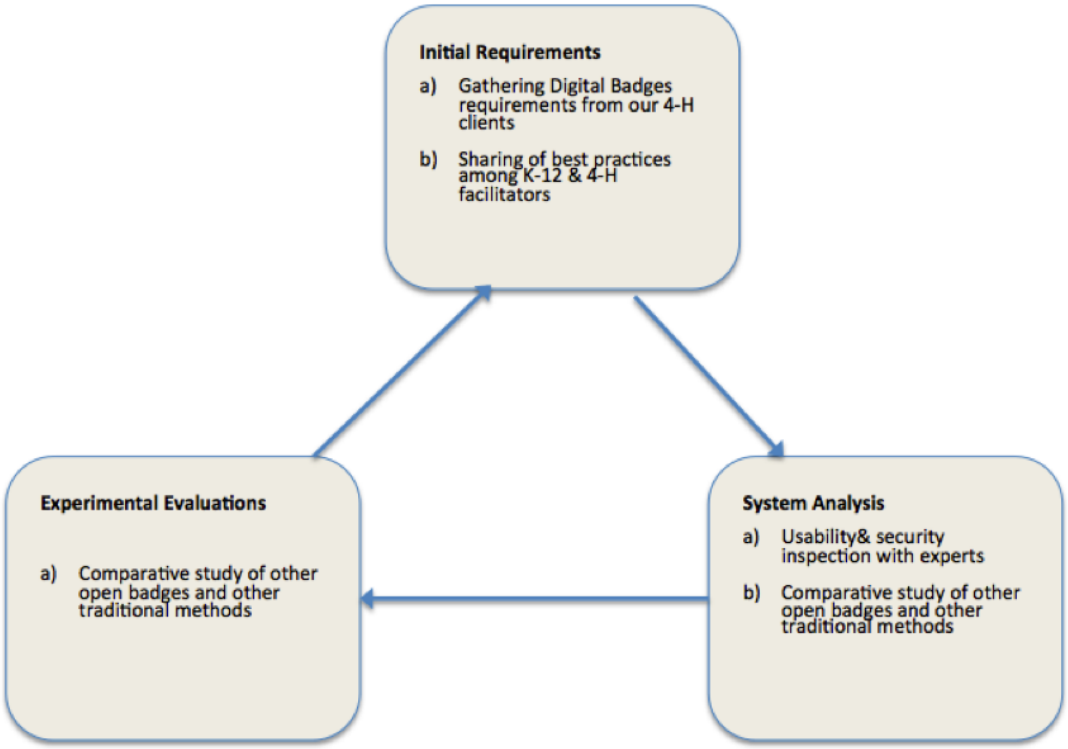


Figure 4.1: Requirements Analysis (reminiscent task-artifact cycle)

4. The application must provide a good overall user experience, meaning that the user should be able to easily use and learn the application.

In order to start and fulfill the first requirement that the application must be web based, common internet technologies such as PHP and AJAX were used for the server side scripting and HTML, CSS3 were used for the front-end, and MySQL was used in order to manage the databases of the system. As our target audience involves kids of different age groups, an interesting and useful User Interface must be the basis of our application. In order to do that, HTML, CSS3 were utilized. Consistency throughout the site was maintained. Secondly, an interactive and dynamic site that has the ability to enhance learning for the users. In order to make dynamic website use of JavaScript and PHP was done. The third requirement was to make it an interactive application. The purpose of such an interactive application is two fold. First, interactive-ness allows the user the ability to input dynamic information into the application. The fourth requirement is that the application provides a good user experience. This requirement is achieved by making the website intuitive and pleasing in their presentation. The challenge in creating beautiful UI element is that everyone who uses the software is different. As a result of which it is difficult to find the balance between metaphor and design in the software layout.

4.1.3 Core Requirements

Following are the main requirements of the system, which are critical for the system design:

1. Design and development of customized user registration system.

2. Design and development of 4-H Badge directory.

3. Mechanism for new badge submission.

4. Badge functions and its compatibility with Mozilla's open badges infrastructure.

5. Design and development of badge pages.

6. Specification and mechanism for earning a badge.

7. Design and Development of 4-H Backpack.

8. Design and Development of reviewer pages.

9. Administrative functions.

The first requirement of the customized user registration features is to walk through the registration process that is explained below. In the "Create New Account" once the user enters "First Name" and "Last Name" and then chooses "Youth" or "Adult" – youth choice goes to Youth Registration. Adult choice goes to Adult Registration (see figure 4) In the "Create New Account" when a young person enters their birthdate the age will be generated automatically. For the Youth Registration, if Age is less than 13 then parental permission is required, must obtain Parent E-mail Address to communicate with parent. Upon receiving the Parent/Guardian e-mail address a message will be sent from the System to the Parent/Guardian with TWO OPTIONS. Option 1 - Parent must confirm Child Name and Age and chooses to simply give permission for them to use the 4-H Digital Badge System. Option 2 - parent chooses to register as a user and have access to their child's information.

For Youth 13 through 18, the process is a bit different and is explained below. Part A – Child simply logs in for the first time choosing a password. Initial welcome message when they first log in may be added. **E-mail confirmation of registration (validation of user)** and welcome is sent Upon confirmation they can now use the system Default group affiliation will be an **Individual** option, which aligns them to the local **4-H Agent**.
For the second requirement, which is design and development of 4-H Digital Badge directory, The requirements are defined below: This directory will show all badges submitted into the 4-H badging system including youth badges and those related to 4-H for adult earners. Directory information for any given badge includes badge details (metadata, except for

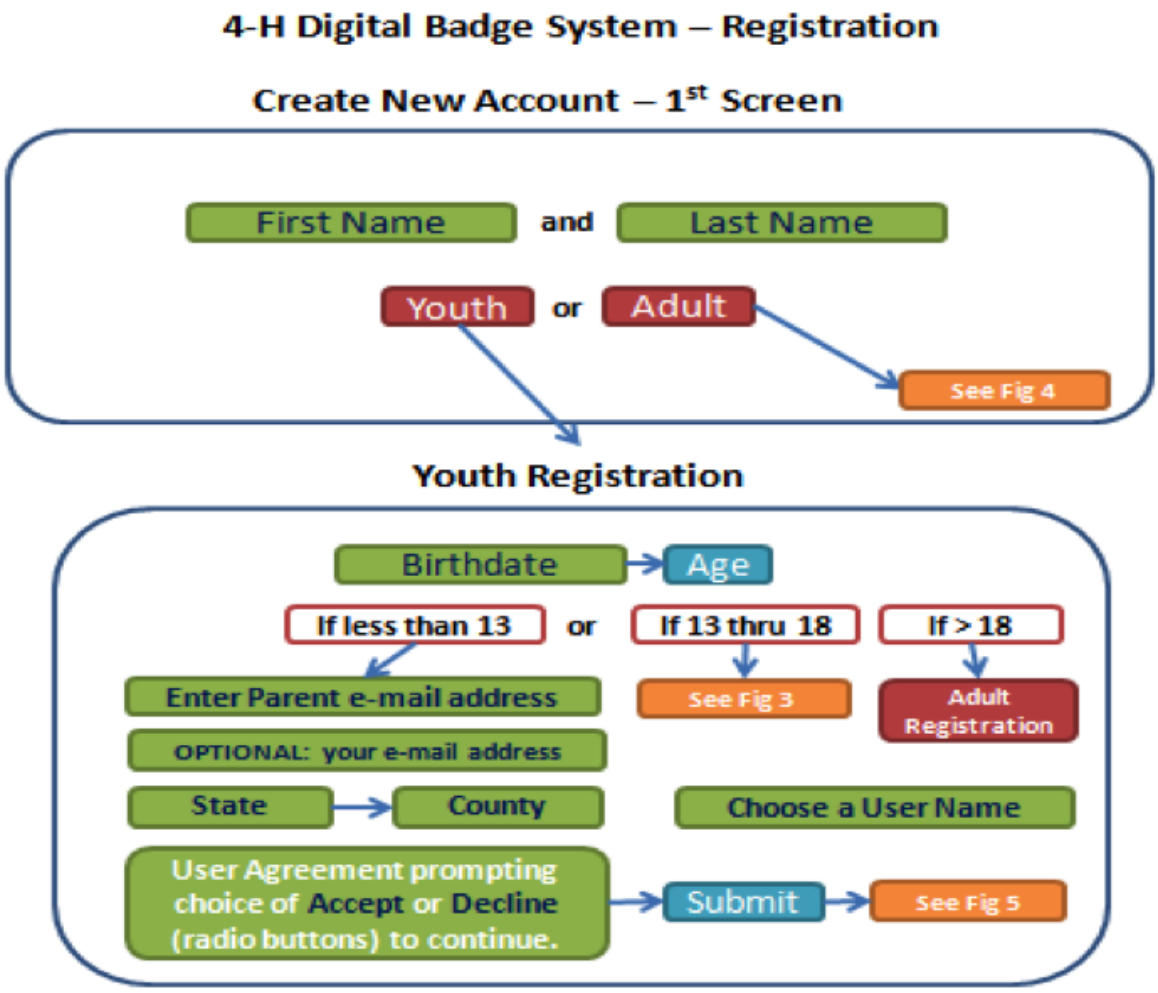


Figure 4.2: Registration Process

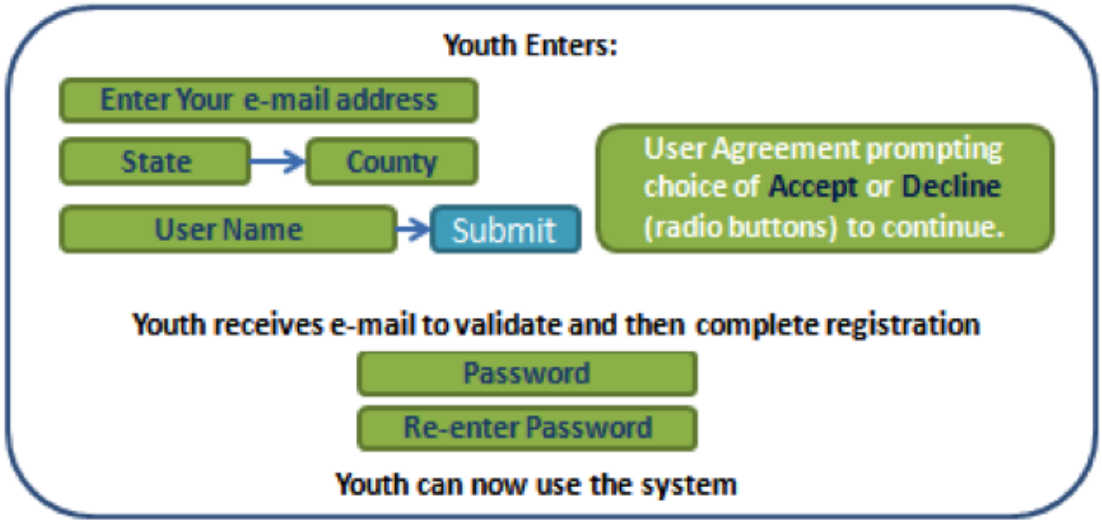


Figure 4.3: Registration process for youth 13 thru 18

"Issued to" and "Evidence URL") that are OBI compliant (badges are baked - ready to be earned). A badge page will be shown with all this information. Related badges may be shown here as well (see Badges below). Badges may be national, state, or locally (county, region or district) approved which would be shown in the metadata for any given badge.

Current Badges:

- Robot Hands
- Robot Movement
- Robot Mechatronics
- Robot Platforms
- Robot Competitions

Adults Badges Being Developed:

Experiential Learning

Inquiry-Based Learning

4-H Robotics Badge Issuer Training Module

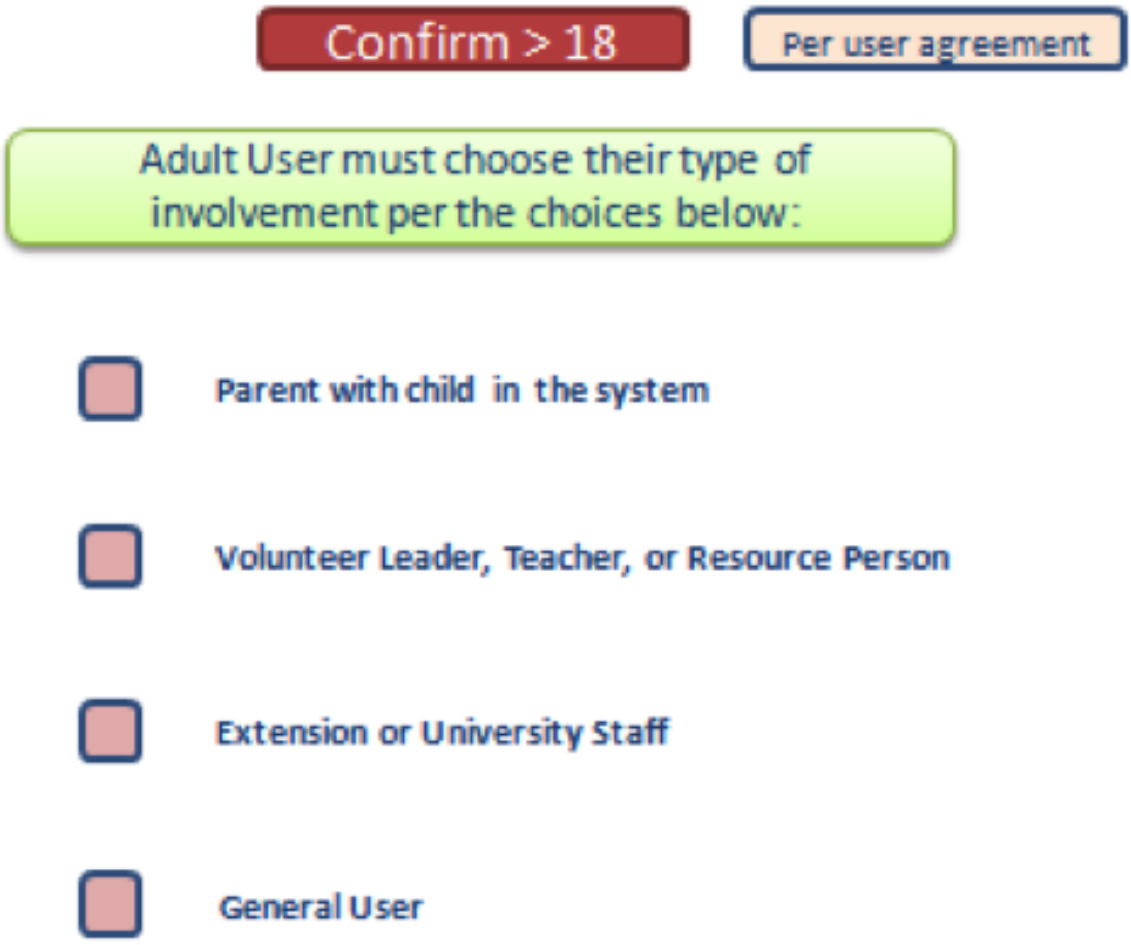


Figure 4.4: Registration process for Adults

Figure 4.5: The Badge Directory

The third requirement, which is the mechanism for the new badge submission is to design a way where a form is created and which collects the information and then the meta data is embedded in the the respected badge image. The following paragraph will explain things in a bit more detailed fashion. Badges to be submitted into the 4-H Badge Directory must be done per 4-H requirements. A badge submission function is needed to input badge information, criteria, badge image and any other information that is needed for badge assertions to be OBI compliant. Only approved adult users are allowed to log into the badge submission site (Create a Badge to show on their profile page). Upon acceptance of the badge into the directory, instructions will be provided for adding programming code for the last page or step of the badge earning process.

For the fourth requirement, badge functions and making them compatible with Mozilla's Open Badge Infrastructure following are specification:

Directory

Browse badge/course categories

Browse badges/courses

Search badges/courses

View badge details (with an image and thumbnail) badge display

Start earning a badge per criteria requirements.

Earned badge pushes to My Badges — badge issuance to custom backpack (per 4-H)

E-mail message sent to earner to confirm (youth or adults)

Push to Mozilla's Open Badges Backpack (except for youth ¡13) badges are OBI compliant

Not automatic but prompted by the user if older than 12

Option to "Share" or "Make Public" to be included on a single badge or via *myCollections*

Individual badge pages show the description of any given badge along with the criteria for obtaining the badge. Each badge page will be a link or button that starts the process of earning the badge. When a person visits these pages and chooses to earn the badge, they will be directed to the Login/User Registration site and then to the earning site. From there the user follows instructions to submit requirements for the badge.

For the sixth requirement, which is the mechanism for earning a badge following are the specification.

The process of earning badges in the 4-H system will vary from automatic issuance upon completion of requirements stated in badge criteria to review and approval of work submitted per requirements for any given badge.

For the seventh requirement, design and development of 4-H Digital Badges following are the specifications. Youth User Profiles (*myBadges*) will consist of a home page that shows badges earned and a "My Collections" section in the main page. When a badge is clicked on the myCollections part slides out while the Badge Details for the badge clicked slide in below the "Current Badges" section. The myCollections will be seen as a link in the upper right part of the screen when Badge Details are shown below. An additional feature is to be added for "Related Badges" that will show when Badge Details are shown. Figure 6 exemplifies how the backpack should look like. **Note:** Parents will need a profile similar to adult admin

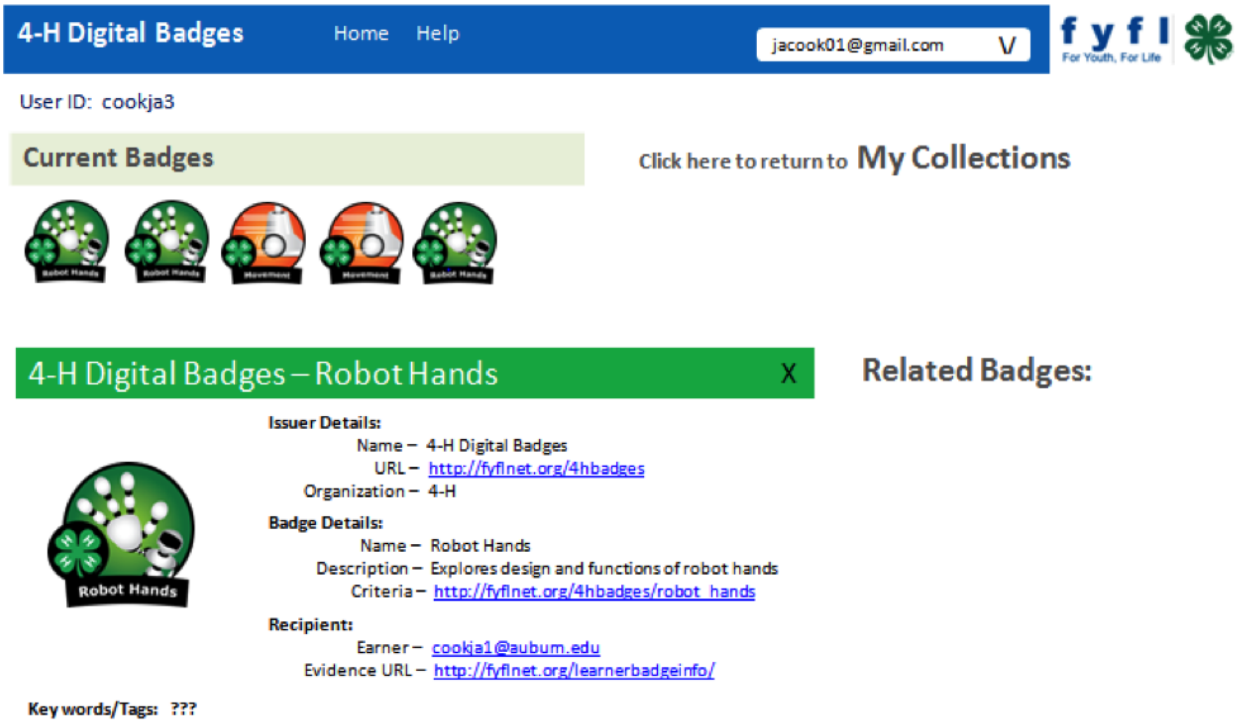


Figure 4.6: Back Pack

profiles with a *myBadges* function and a *My Children* function (lists name(s) of children). Clicking on names of children will give the parent access to the child's myBadges profile.

For the eight requirement design and development of reviewer pages. The specification is described in the following lines. Current youth badges each lead to an "Adult Facilitator Page" where the responses submitted by the badge earner have been summarized. The information will be reviewed by the adult facilitator with an option of returning the page to the earner for additional work. Upon approval of the submission the badge is approved or issued.

For the ninth requirement, as there are different levels of admin, so each level have different privileges in the system. These different privileges will be described below. The overall system has multiple levels of administrative functions beginning with Super Admin (nation or country level); State Admin; County/Region/District within a state; and Group or club level at county level. Review and approval, including revoking, of badges will be integrated into the scheme of administrative levels and permissions. A primary control panel will be

utilized.

Scheme of Administrative Functions

Category 1

Level 1 – Super Admin

managers at the system level

all functions of the system are available

Category 2

Level 1 – State Admin

Coordinator of activity within any given state

can issue any badge to any person within their state

Level 2 – County, Region or District

coordinates activity within their area including management of Level 3 Admins

can issue any badge to any person within their county, region or district

Level 3 – Local Club or Group (volunteer adults, teachers, others)

Only reviewer functions are available

Can only review users they are approved to interact with

Note: All issuers of badges must complete a training course before being approved for issuing badges.

Category 3

Level 1 – Adult users (non-admin users (no youth interaction), parents or guardians)

Level 2 – Youth users (non-admin, connected to parents or guardians)

Category 4

These are general users aged 19 or older; college students, professionals, faculty, etc.

Can only earn badges **Various functions include:**

Add/ edit/ delete categories

Add/ edit / delete badges

View historical badge earning of a person.

Review and approve badges

Issue a badge to a person

Connect the system to courses in Canvas or other course sites

4.2 Phase II: Detailed Overview

Once all the requirements were specified and agreed by the design and development team and system development began. After careful consideration a wide range of technologies were utilized in order to develop the system, along with this wireframe diagrams were designed for the system.

4.2.1 Wireframe diagrams

Once all the requirements were finalized, wireframe diagrams with initial views of the system and, all functional requirements were designed. Many wireframes were designed for the each category, but in this draft we only illustrate the finalized ones. This forms the basis of our development. Figure 4.7, depicts how the perspective home page of the system will look like, with all the menu options and the content and the location and size of the images and logo were decided.

Fig 4.8 shows the overview page which is on the navigation bar, explaining the working and details of the system.

Figure 4.9 make the learner familiarize with what are badges, what is the benefits of using badges, mechanism to earn a badges etc.

4.2.2 Tools and Technologies Utilized in the Development Process

In order to develop the system we followed the dynamic system infrastructure, below is in brief detail on how it works followed by the figure, which explains the flow on how the requests are interpreted.

- Client/User sends an HTTP Request with a URL.

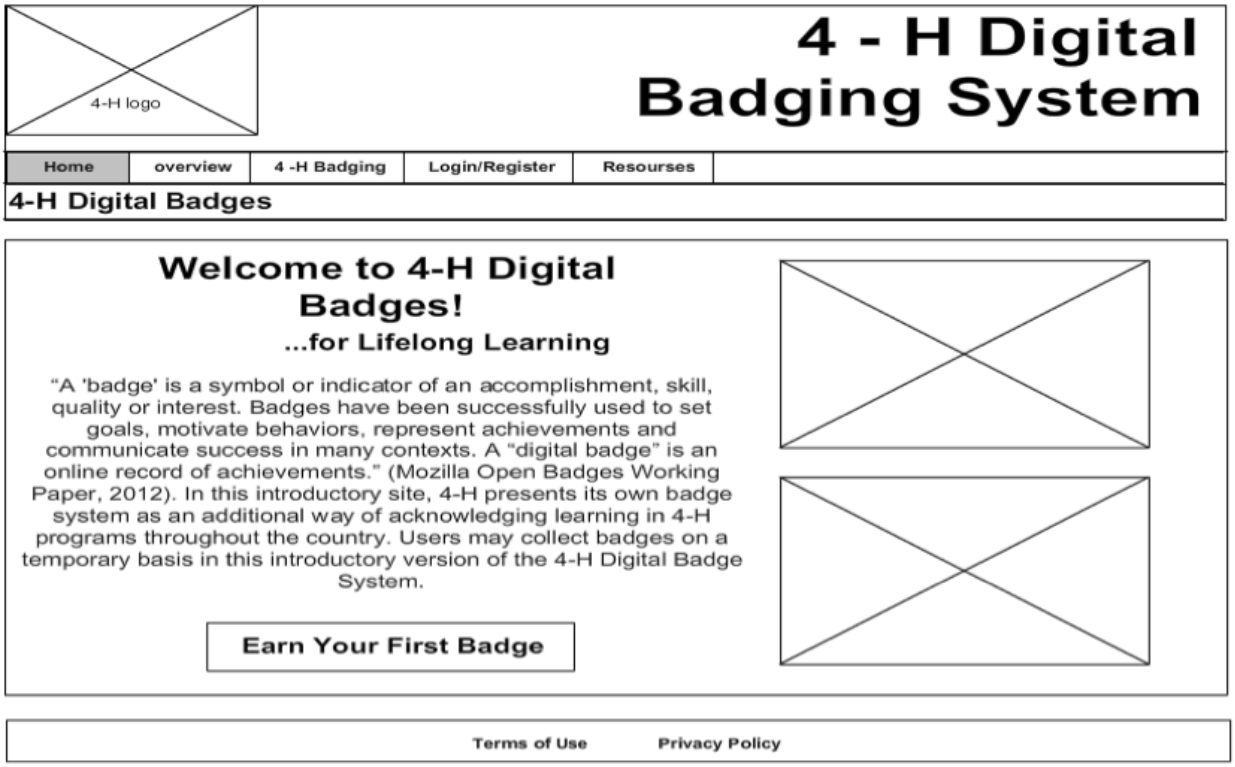


Figure 4.7: Wire Frame: Home Page

- HTTP Server dispatches request to the application server.
- Application Server dynamically constructs HTTP response, sends it to the HTTP Server and HTTP server sends the content to the User.

The dynamic development process consists of two aspects, which forms the basis of our coding languages selection. The front-end and the back-end, both work in tandem to create a web-based application. In a pith, the front-end development is what is used to create the visual display that the end user of a application experiences. Back-end development is what makes the presentation of the front-end possible. When a user attempts to access an application via front-end interface, the relevant information is verified by the back-end database, and the proper information is then presented to the user via the back-end web server.

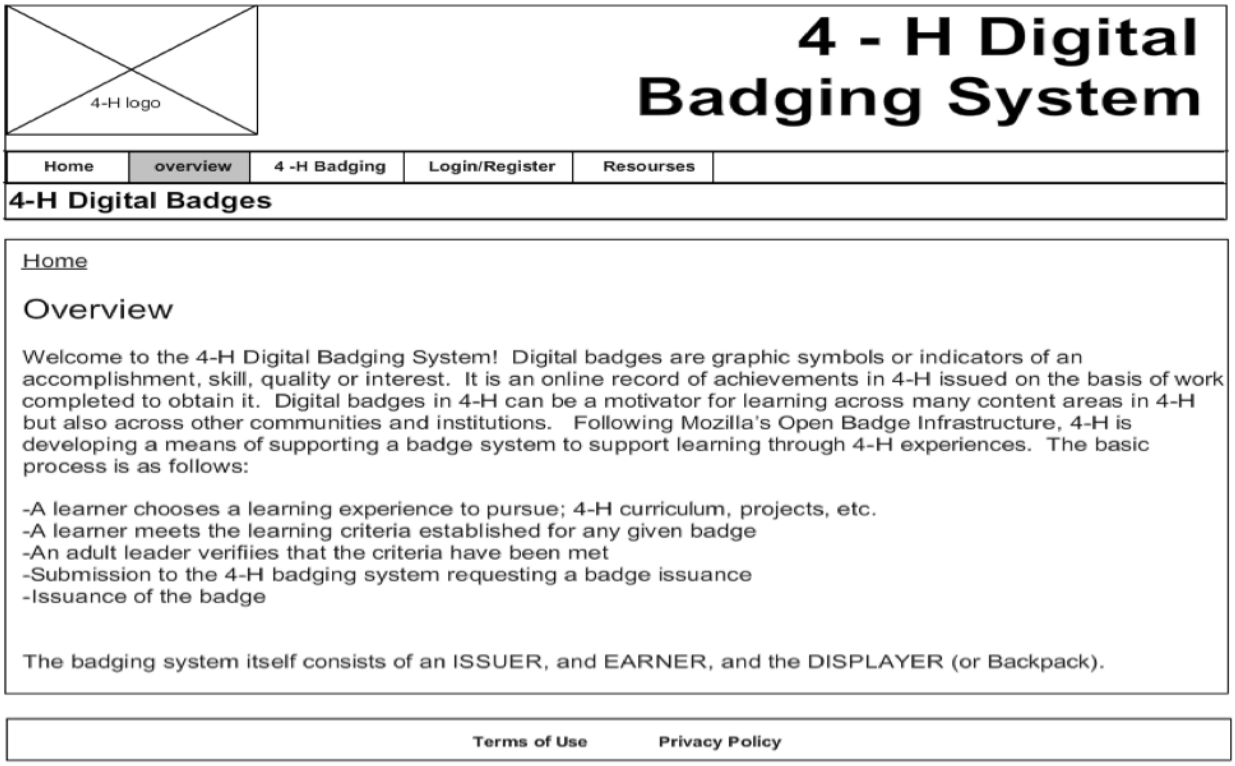


Figure 4.8: Wire Frame: Overview

4.2.2.1 Back-end

PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. It has been widely used. While originally it stood for Personal Home Page, it now stands for PHP: Hypertext Preprocessor.

PHP code can be mixed with HTML code, or it can be used in combination with various templating engines. PHP code is usually processed by a PHP interpreter. PHP code is usually implemented as a web server's native module or a Common Gateway Interface (CGI) executable.

It's main purpose in this project is to create dynamic and interactive pages, used to design the registration system, validating and registering users, interacting with the database, store all the current badge directory etc.

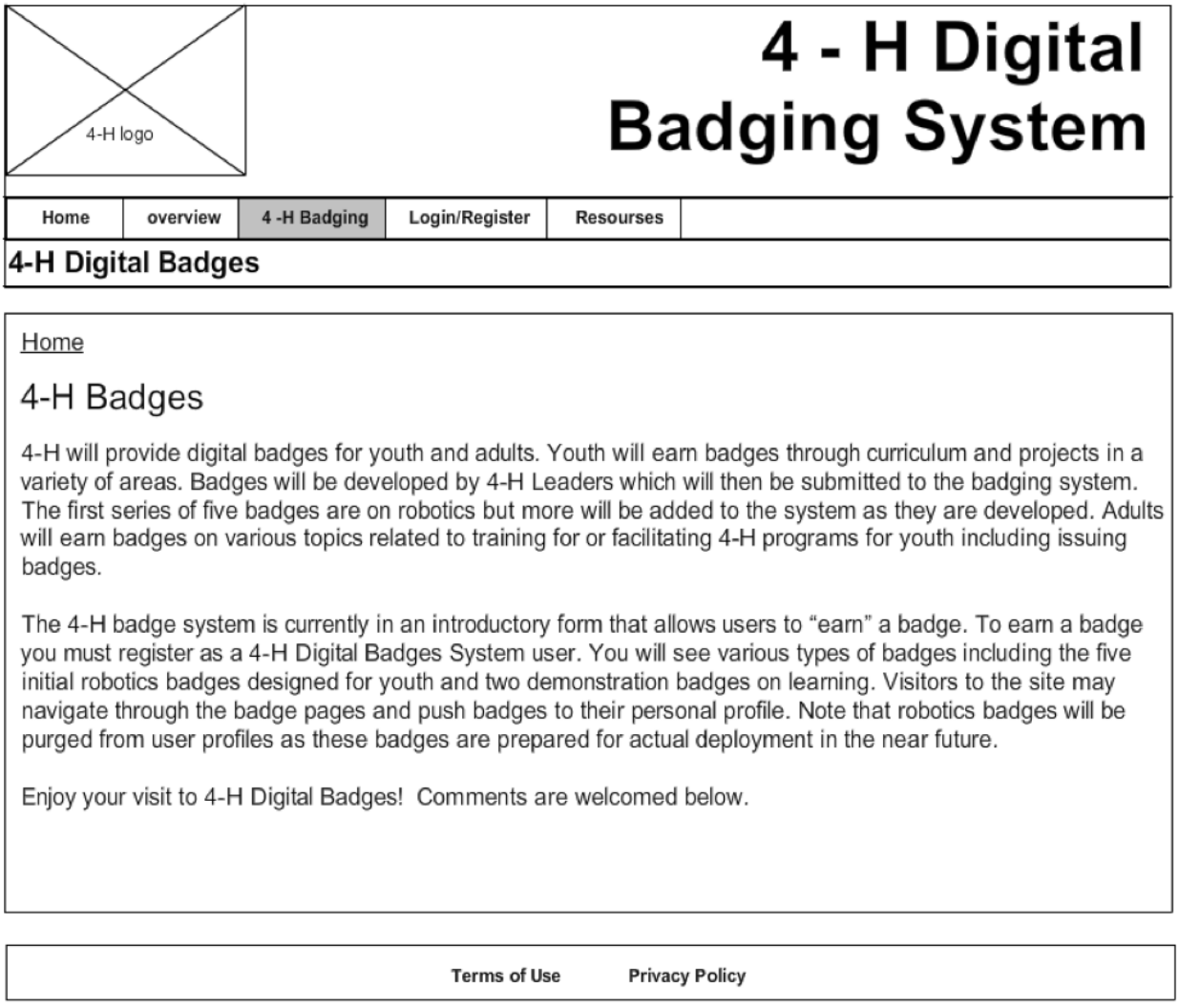


Figure 4.9: Wire Frame: badges

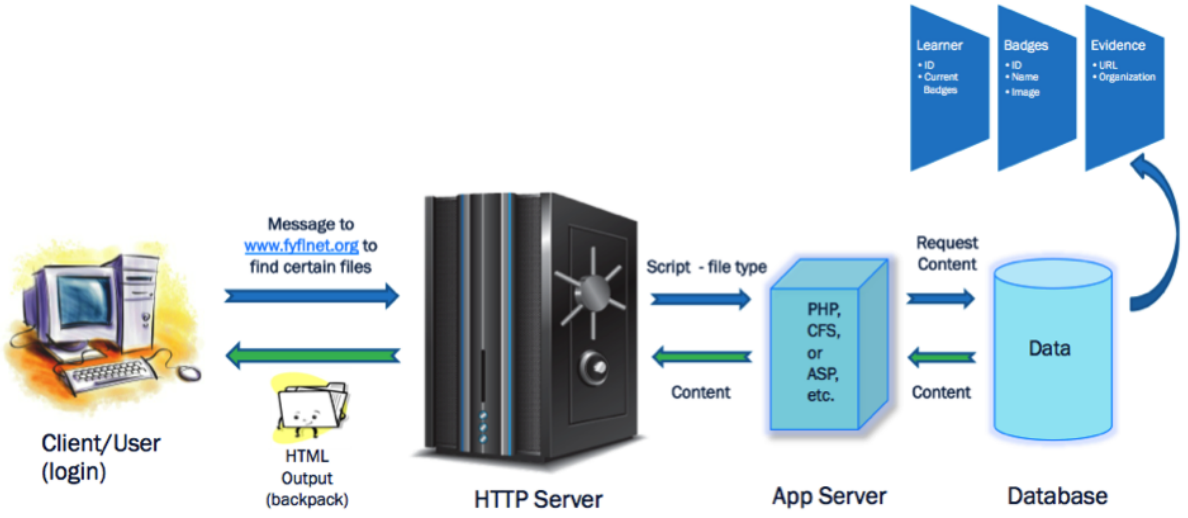


Figure 4.10: Architectural Structure

4.2.2.2 AJAX (Back-End)

Ajax allows for a new and better way of building interactive web pages. Ajax combines several technologies such as JavaScript, dynamic HTML, XML, Microsoft object, XMLHttpRequest, CCS, and DOM. Ajax allows an immediate update to a webpage in response to user input. HTTP requests require the page to be reloaded to reflect changes while Ajax can update immediately.

4.2.2.3 Zend Framework

It is an open source, object oriented framework, with some of the features like it supports extensive MVC implementation supporting layouts, email composition and delivery, use-at-will architecture etc.

The purpose of using Zend in our project was the reason that there were a lot of instances where email messages were required.

4.2.2.4 HTML5 (Front-End)

HTML5 is the fifth version of the HTML. It is a markup language for structuring and presenting content for the World Wide Web and a core technology of the Internet. HTML5 introduces a number of new elements and attributes that are useful in developing modern websites. Also, one of the main advantages of HTML5 when compared to Adobe Flash is it does not require any additional plug-ins to download and install. This is the main rationale for developing animated case studies in this application using HTML5 instead of Adobe Flash so that it can support all browsers and mobile devices.

Also, HTML5 is used to develop rich mobile applications for mobile devices. The new features of HTML5 standardize the technologies that are frequent in different mobile web applications. With the use of HTML5, advanced web application features are available in all mobile browsers supporting the markup language. Applications that are developed using HTML5 are browser friendly; hence, they save money and time when developing different applications for multiple browsers.

HTML5 has included many new syntactical features, such as the <video>, <audio> and <canvas> elements. All these elements are supported by the current versions of Mozilla Firefox, Google Chrome, Internet Explorer, Safari, and Opera. These elements are designed to make it easy to include and handle multimedia and graphical content on the web without depending on plug-ins and APIs. The <video> and <audio> elements are used to develop this application. The <video> element is the standard for playing <video> files and <audio> element is the standard for playing audio files.

4.2.2.5 JAVASCRIPT (Front-End)

JavaScript is implemented to provide enhanced user interfaces and dynamic websites. Since JavaScript is the only language that the most popular browsers share support for, it has become a target language for many frameworks in other languages, even though JavaScript was never intended to be such a language. JavaScript functions are embedded in or included

from HTML pages and interact with the Document Object Model (DOM) of the page. The FYFL application uses jQuery, which is a cross-browser JavaScript library for most of the controls.

4.2.2.6 MySQL (Back-End)

MySQL (My Structured Query Language) is a popular open source relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases. MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. Free-software-open source projects that require a fully featured database management system often use MySQL. For commercial use, several commercial editions are available and offer additional functionality.

A few applications that utilize MySQL databases include: Joomla, wordpress, Drupal and other software built on the LAMP software stack. Also, MySQL is used in large-scale World Wide Web products, including Wikipedia, Google, Twitter and Facebook.

SQL is a query language that is used to retrieve, insert, delete and update data in the database. This is achieved by constructing conditional statements that conform to a specific syntax. MySQL Server is installed and can be accessed directly via various client interfaces, which send SQL statements to the server and then display the results to a user. The FYFL application uses MySQL database to store the information such as usernames, passwords, and emails of the registered users.

4.3 Design

Design decisions are one of the most critical stage of the whole development. The benefits, if chosen the correct design are immense. Developers can easily maintain and can analyze the issues arising while in the processes of building the software, not only this it

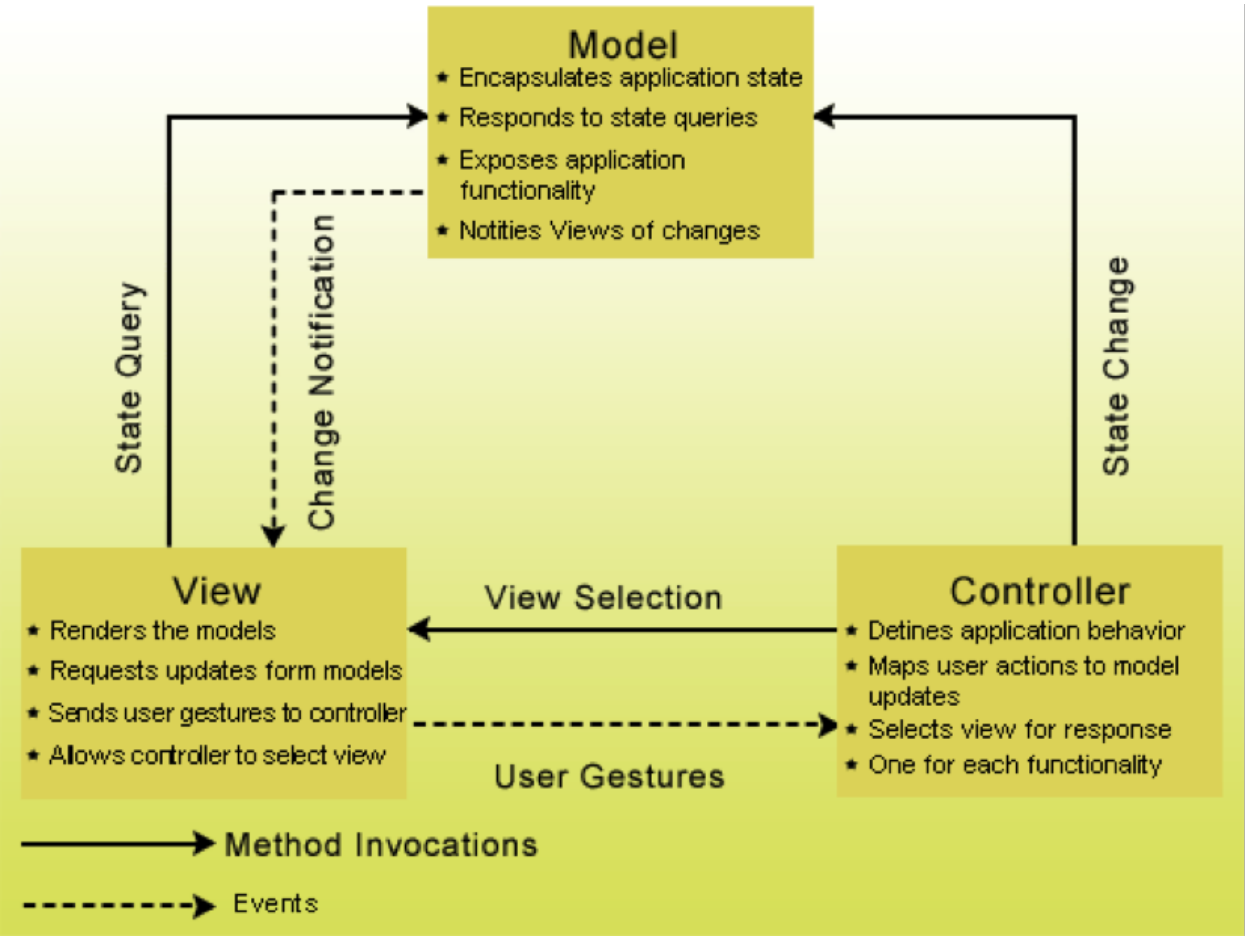


Figure 4.11: MVC Architecture

helps in testing too. Two design patterns, MVC and singleton design patters were chosen for the scope of this project. Following is a brief description of the project.

4.3.1 MVC Design Pattern

The model-view-controller is a classical design pattern that separates the business logic from the UI logic and control flow logic. This allows for maximum maintainability and scalability. The components to the MVC pattern are:

1. **Model:** The model manages the information that the application uses. It notifies observers if there is a change in the information. The data is kept persistently and can be manipulated by the controller.

2. **View:** The view displays the data kept by the model to the user. It also takes user input.

3. **Controller:** The controller is the main hub of the application. It handles all requests from the view. These requests are forwarded to the appropriate handlers. The controller is the only module that can access and extract the data in the model.

4.3.2 Singleton Design pattern

The singleton design pattern ensures that a single instance of a class is created. This single object has a global access. In our system, the database connection was maintained as a singleton for importing data from the access classes.
Once we came to a conclusion of what languages to be utilized and what frameworks and architectures to follow, development process was started and the results of the products created will be shown in the next chapter.

4.4 Phase III: FYFL Drupal

In this section of the chapter we will discuss the rationale for FYFL Drupal and this iteration of the design and the system limitations, which makes the product in phase II better. Both 4-H Digital Badges and FYFL Drupal were created within the same frame of time. Based on the task-artifact cycle the Drupal version came into existence. Complete requirements were given to an IT company and an AGILE METHODOLIGY was followed in order to monitor the progress of the whole application.

4.4.1 Limitations and moving back to the original version

After analyzing the Drupal version of the FYFL application, several conclusions were drawn though it met all the requirements but there were many fallacies attached to it. As it was built on Drupal, the system was not secure (can be easily hacked) also it was not scalable as our application has a potential of 4 million users across the country and if the

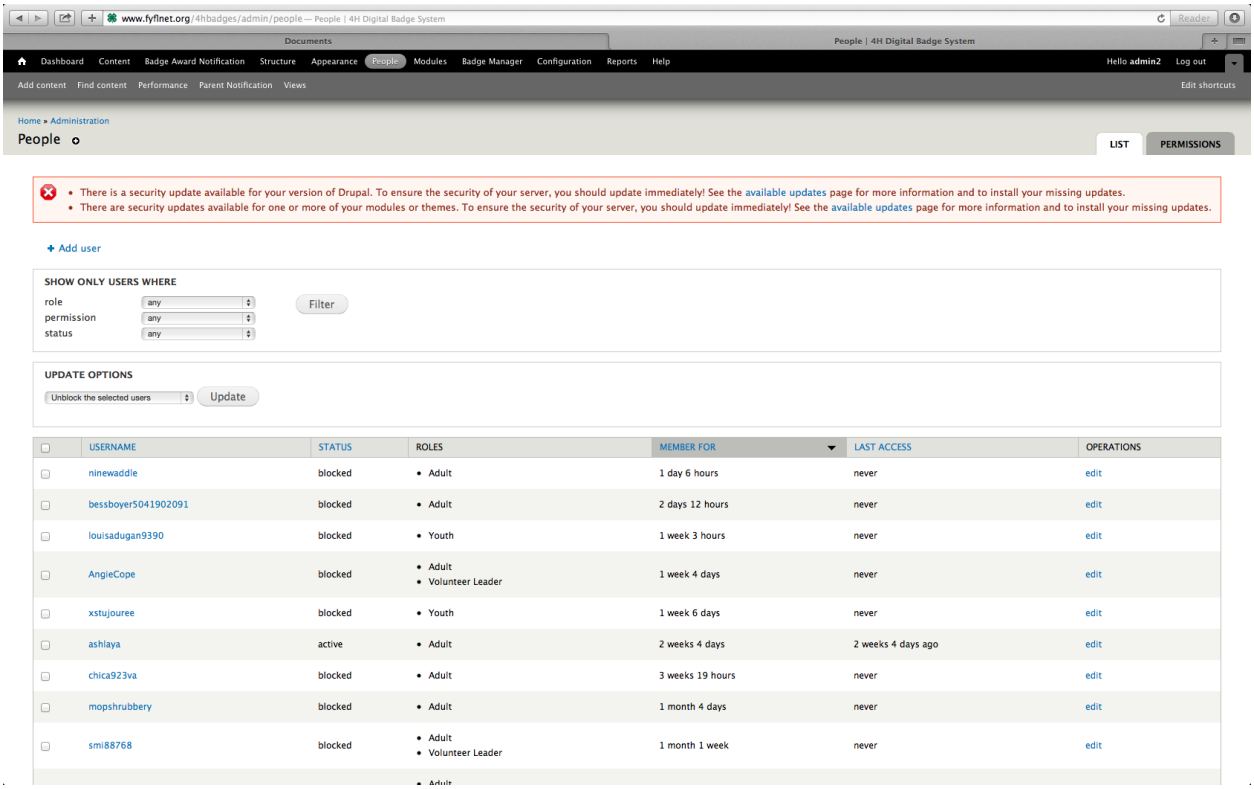


Figure 4.12: Drupal Admin Dashboard

application cannot perform well as the number of users increase that will lead to an unwanted situation. Not only this dashboard, for the admin user is a complex ocean once entered it is very difficult to change whatever is required. It becomes very difficult to navigate, not only this in many cases it won't be enough to able to create the best possible UX and usability for the system. Figure 1 shows the complex dashboard of the Drupal system. Not only this, a specific comparison test has been done by 4-5 testers of the system and following conclusions were drawn which led us to design completely new system from scratch.

4.5 Phase IV: Design and Integration of the next iteration and its security

Once the original system was developed, the next iteration development was started with the intention to make it more secure and to improve its intuitiveness and make it more aesthetic. The framework was kept the same, but we moved to the one-page design for the application. Also we used a lot of AJAX considering it's several benefits, which will be

discussed, in the following chapter. One page design basically can be described as the one that fits on a single web page with the goal of providing a more fluid user experience akin to a desktop application.

4.5.1 Single Page Designs

One that fits on a single web page with the goal of providing a more fluid user experience akin to a desktop application. Few of the major reasons industries are shifting to single page designs are it ease of use against the complex multiple pages which require a lot of time to navigate. Following are the list of reasons, which made us move to the single page design option.

- No page refresh when navigating the site (content is either in the page or loaded using Ajax)
- User experience can be improved because navigating through content is quicker and more responsive than having to go to a new web page.
- Easier maintenance because you only have to maintain one web page
- Can be design for quality over quantity, instead of having to design multiple page layouts for different types of site content, you can focus on just one solid and high-quality design
- Your Google PageRank applies to the whole site
- Higher core content density for search engine spiders
- Distinction from most other websites; single page websites are less common, and can thus leave an impression on your site visitors
- Preferred solution for web apps designed for the Mobile Web

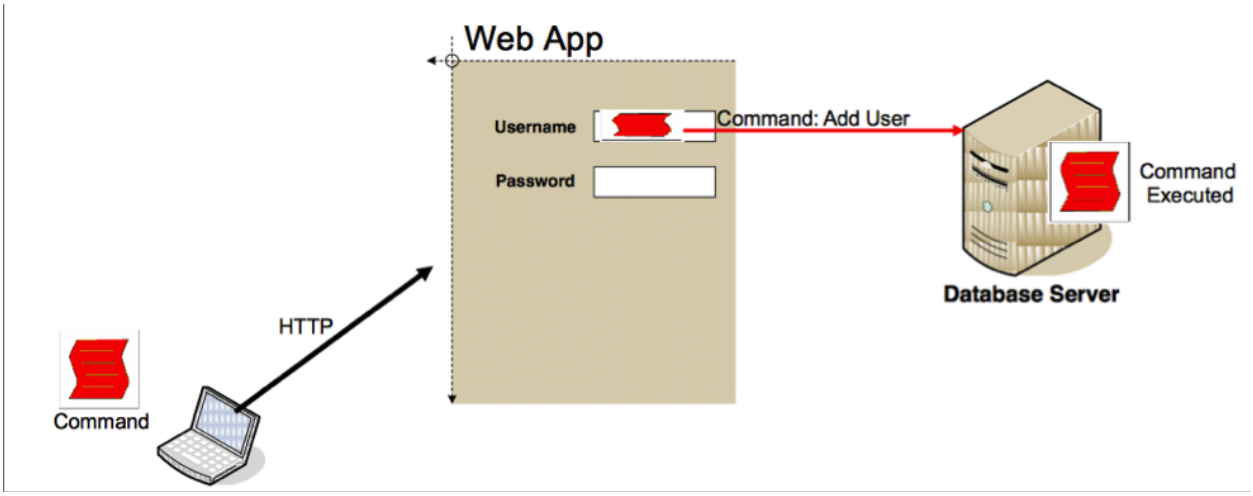


Figure 4.13: SQL Injection

We have identified a need for using AJAX in order to load pages without refreshing the page thereby making the end product faster and more efficient. AJAX has been used as supporting language in order to design this more efficient iteration of the new system.

4.5.2 Security issues, its need and steps taken to reduce attacks

Attacks on applications are the most common issues, which are prevalent these days, and provisions in order to protect those attacks should be made before hand as it can lead to important information/privacy leak and attacks. FYFL 4-H Digital Badges is an application, with target audience as children and because of COPA information should be protected. In order to deal with this situation, various security issues were identified and then after careful consideration and thinking, solutions were designed.

4.5.2.1 SQL Injection, problem identification

SQL injection was identified as one of the major security risk to our application. SQL injections are basically the ability to send command to the backend servers for execution. Input field that are not are not validated become a medium of transfer for malicious code, commands and scripts. SQL commands (INSERT, DROP, GROUP BY etc.) are the most common commands which can be injected by the hacker in order to attack the application.

SQL injection often requires "tuning" of attack code. Real applications are complicated and use complicated requests, but several techniques exist to massage data from error messages, like UNION SELECT operation can access all the tables and error messages can provide the information on number of argument, column name. Blind SQL injection is required by the apps with generic errors, they generally rely on returning information 1 bit at the time, So as a result of blind SQL injection standard trees can be used to determine Schema, actual table data can be returned bit by bit with compares.

4.5.2.2 SQL Injection and its Solution

After careful consideration the following steps were taken in order to prevent the above said situation.

- Prepared/parameterized statements were used.
- Proper use of database procedures were performed.
- Proper input filtering/sanitization was done.
  - E.g. For email inputs, all characters except letters, digits and !#$%?*+-=?ŵere removed.

4.5.2.3 Cross Site Scripting, problem identification

Cross-site scripting (XSS), is also one of the major and most prevalent attacks. It is the ability to post a script and have it execute on a targeted machine (via a browser) from another site, which is basically usually trusted. The most common attacks for XSS includes, sending the target cookie, including the session ID, to the attacker. Capturing sensitive information from DOM and forwarding it to attacker, automating sensitive server-side actions as the authenticated victims. So, the question arises that where does the script comes from? There are inputs without proper input and output validation, post content parameters, cookies and

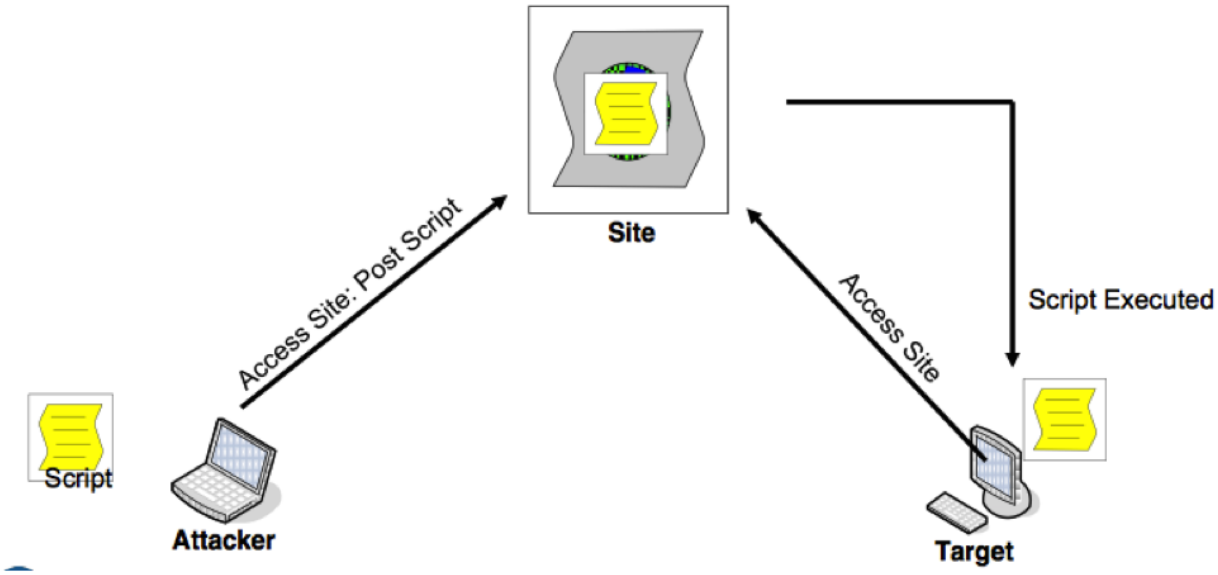


Figure 4.14: Cross Site Scripting

other headers or non-web sources, like user databases. So in order to resist these attacks following steps were carefully thought and implemented.

4.5.2.4 Cross Site Scripting and its solution

There should be proper input validation, just to consider an instance we can filter truly invalid input, like a zip code field do not need A-Z character list. Also we rejected obviously malicious tags. For the output validation we encoded text to context-suitable format, along with this encoding of everything that is not alpha numeric was also implemented.

4.5.2.5 MD5

In order to make the system more secure and add to its robustness message digest algorithms (MD5) was used to keep the passwords encrypted in the database. MD5 is a cryptography hash function, which produces a 128 bit hash value, which is usually a 32 digit hexadecimal number.

4.6 Summary of System Features

4-H Digital badges is an automated and secure application, which provide members of a community of practice an opportunity to create, reuse and share best practices with learners (kids) and peers on a particular topic based on their particular interests. It will also allow members of the community to browse through various other badges and get several details like best practices on a particular topic, what are the requirements to earn a specific badge, and allows them to share their interests. The system will maintain the member's, both learners and facilitators records by creating or updating each record according to the activities done by each individual. Only authorized community of practice members are allowed to maintain these records, which can be achieved by login in into the secure environment. The system can be used to create badges, earn new badges according, create the criterion for earning a badge, and sharing recognition achieved by earning those badges.

4.7 Use Case Analysis

Our research plan is to provide user-friendly means for novice computer users to create, adapt and re-use best practices (e.g. badges, courses etc.) System requirement and careful analysis of the system serve as our guide in building design cases that support the functionality and usability of the system.

To accomplish a detailed analysis and design of the system, we will utilize UML diagram for object modeling. Furthermore use cases and user scenarios were used to analyze and capture the document specification in relation to the target users for our system.

4.7.1 Use Case - I

Name: Creating a Community of Practice or Group

Scope: 4-H Digital Badges, sharing knowledge by creating badges.

Level: User-goal

Primary actor: 4-H Facilitators (administrators)

Stakeholder Interests: 4-H facilitators want to successfully add badges, badge description, requirement to earn a specific badge and pre-requisites skills for the badge.

Pre-conditions: The user should be a valid administrator member of a given community of practice to use the system.

Post-conditions: The communities governing authorities give a list of topics, group admission and a community of practice requirement.

Basic Flow:

1. The user login into the system
2. The user creates a new badge
3. The user enters badge title/version of the badge
4. The user uploads the image he/she wants for that badge
5. User enters description
6. User sets a criteria to earn this badge
7. User sets the expiration date for the badge
8. User adds the meta tags for the badge
9. User adds the badge course ID
10. User submits all the details.
11. The system validates the entry requirements
12. The system saves the details

4.7.2 Use Case - II

Name: Re-Use Of an Existing Best Practice by the learner (kids). **Scope:** Gathering knowledge and thereby sharing it. **Primary Actor:** 4-H Badges youth audience, kids in the system **Secondary Actor:** None **Stakeholder Interests:** Community of Practice Member: Wants to successfully re-use the best practice, practice details, **Pre-conditions:** The learner studies the required course work for the specific badge he/she want to earn. **Basic Flow:**

1. User logins into the system
2. User explores the badge manager
3. User finds a suitable badge to be earned
4. Reads the description and the requirement of the badge
5. Studies the required coursework offline
6. Attempt the quiz, which is unique for each badge
7. Facilitator reviews the attempted quiz
8. Awards the badge to the learner, provided substantial amount of work has been done

Figure X, outlines both of the use cases discussed above.

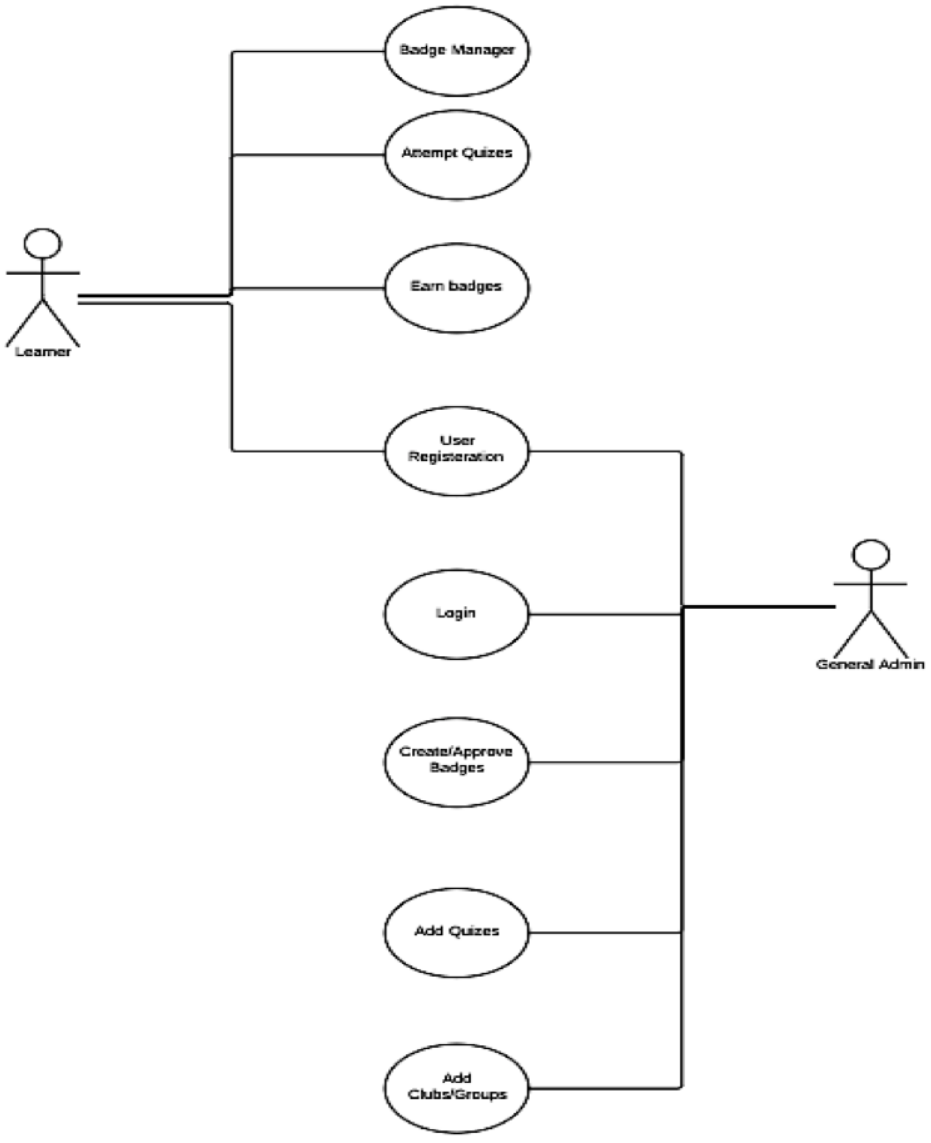


Figure 4.15: Use Case: Learner/Admin

4.8 System Sequence Diagram

After the initial system, several functions and privileges were stated and outlined, the order of user and system interaction need to be stated. We stated this by designing the system sequence diagram. The following sequence diagrams exemplify one of the privileges Admin has (fig x), the view space for the user (fig x), the process of the whole user registration (figure x), and what happens when the user forgets password (figure x).

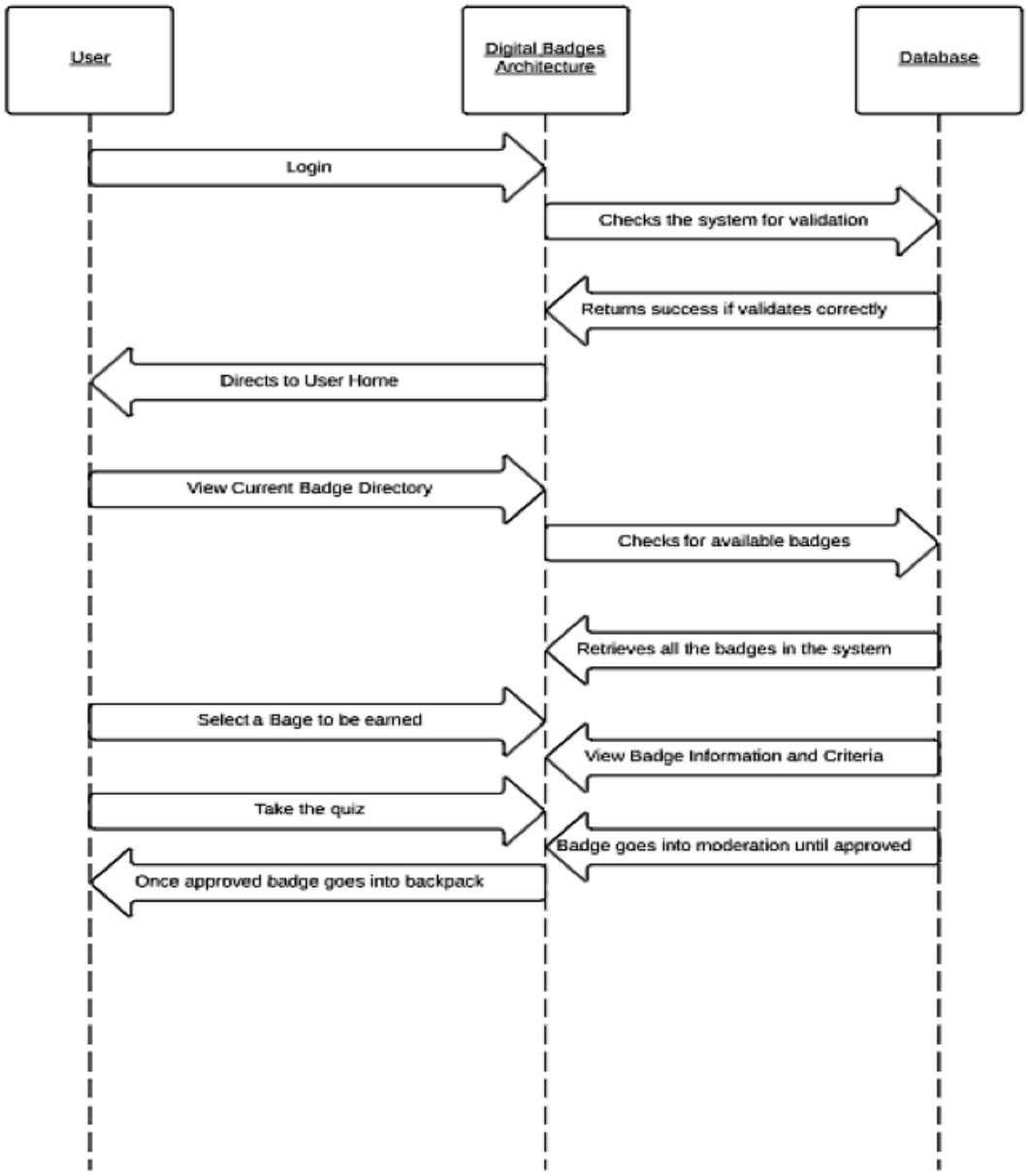


Figure 4.16: Use Case Admin View Space

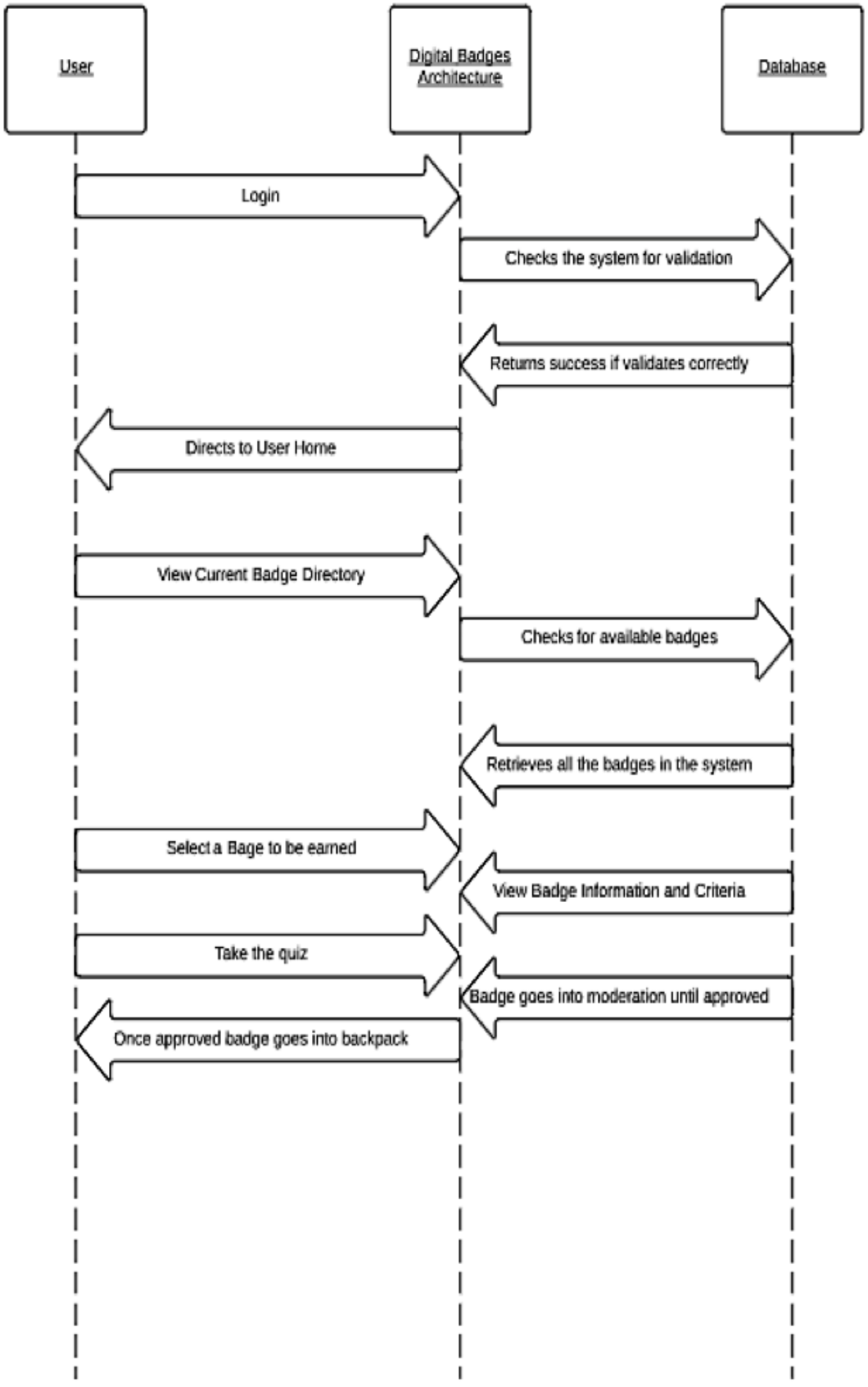


Figure 4.17: Use Case User View Space

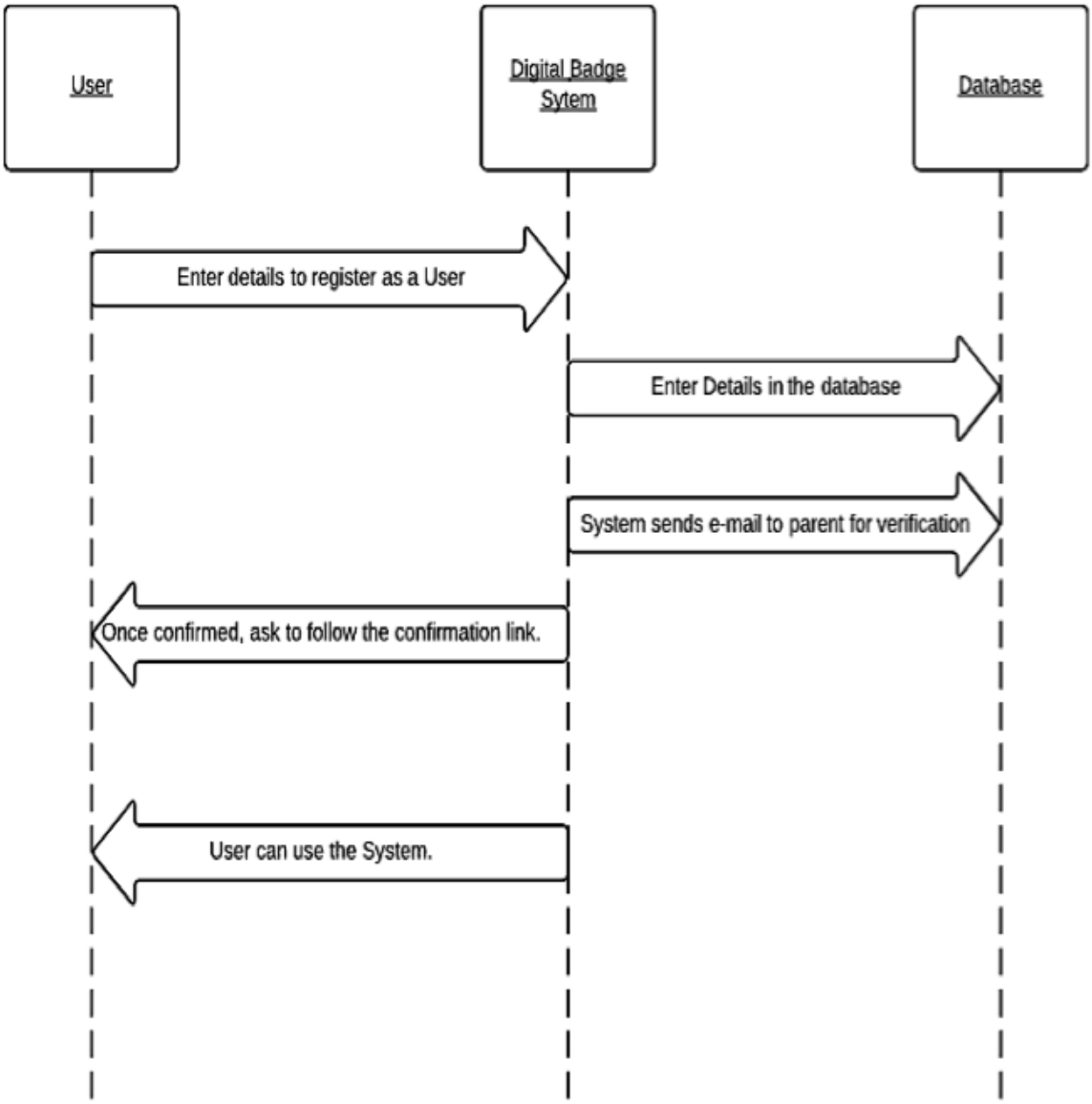


Figure 4.18: Use Case User Registration

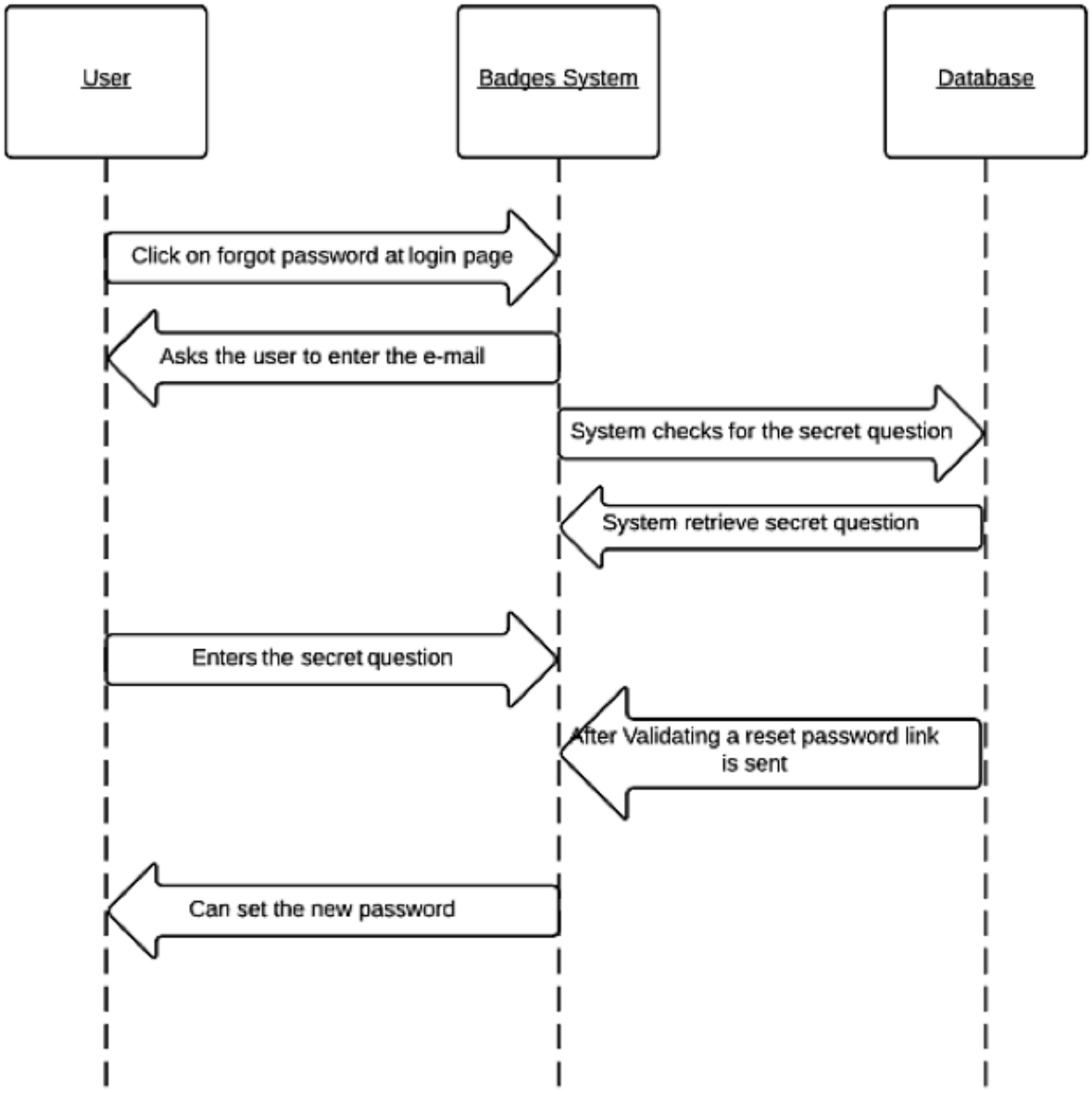


Figure 4.19: Use Case Forgot Password

4.9 Database Architecture

The current database architecture of the entire FYFL system is depicted below. The database consists of tables Hands_Response, Mechatronics_Response, new_Images, users, back_packs, Competition_Response, badges, groups, states, admin1, counties etc. related as shown below. For example, a table Mechatronics_Response containing badge name, badge id, username, user id is related to a table images3 containing badge name and respective badge image information i.e. image name, type, size, date etc.

The figure below depicts database's tables that can be accessed from the files identified for having security vulnerabilities. Mitigating the SQL injections protects these tables from unauthorized access.

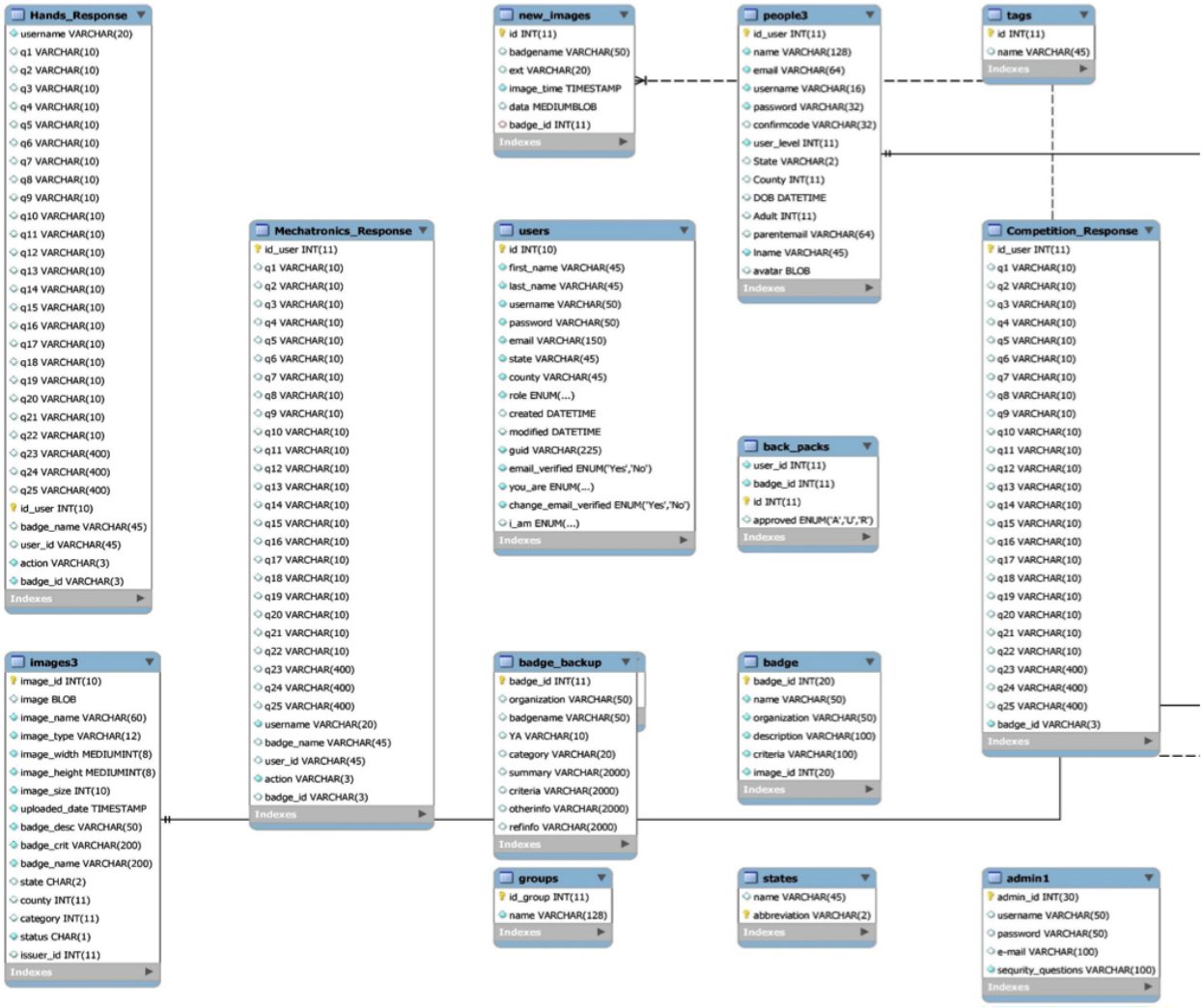


Figure 4.20: Entity Relationship Diagram

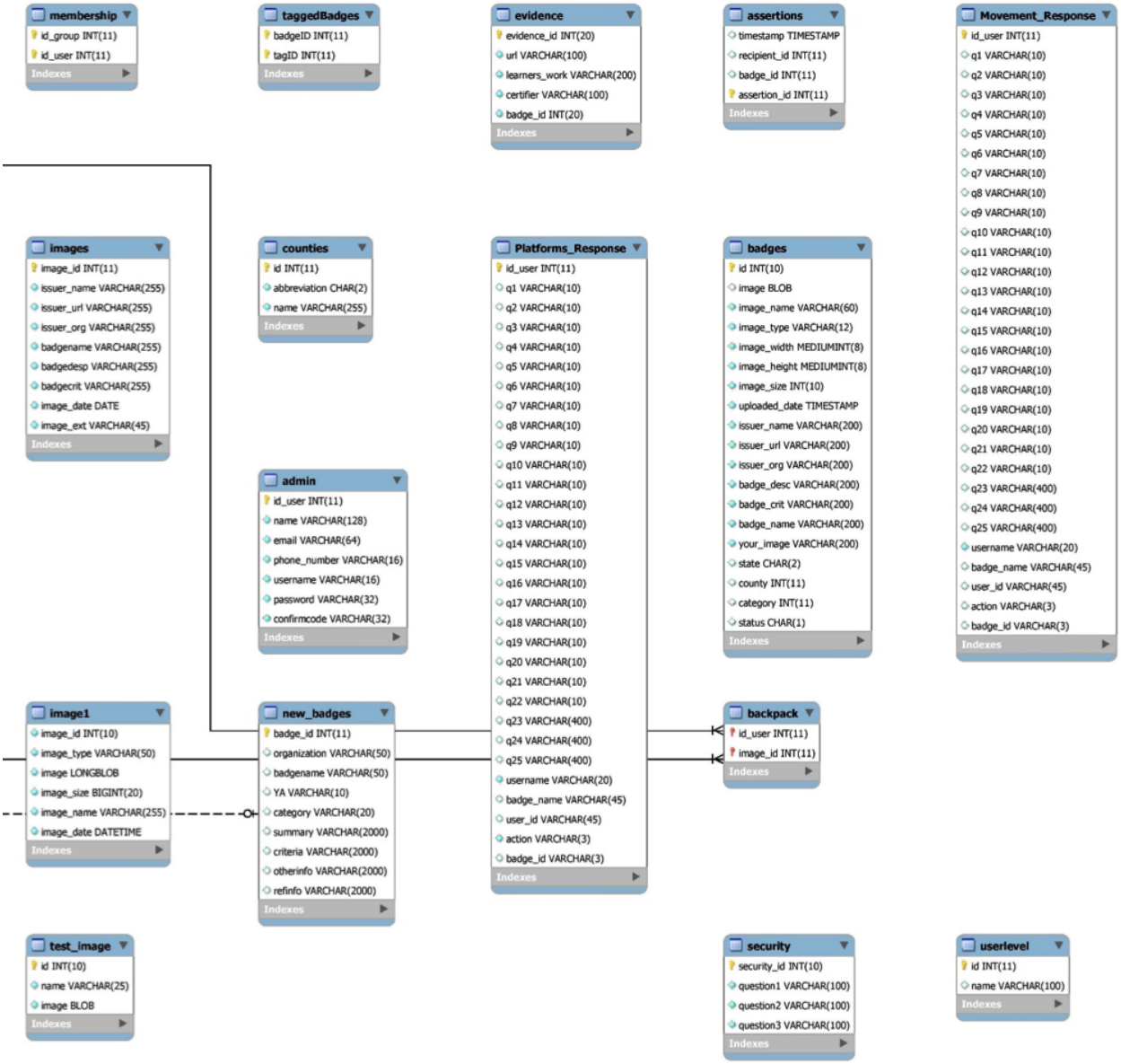


Figure 4.21: Entity Relationship Diagram

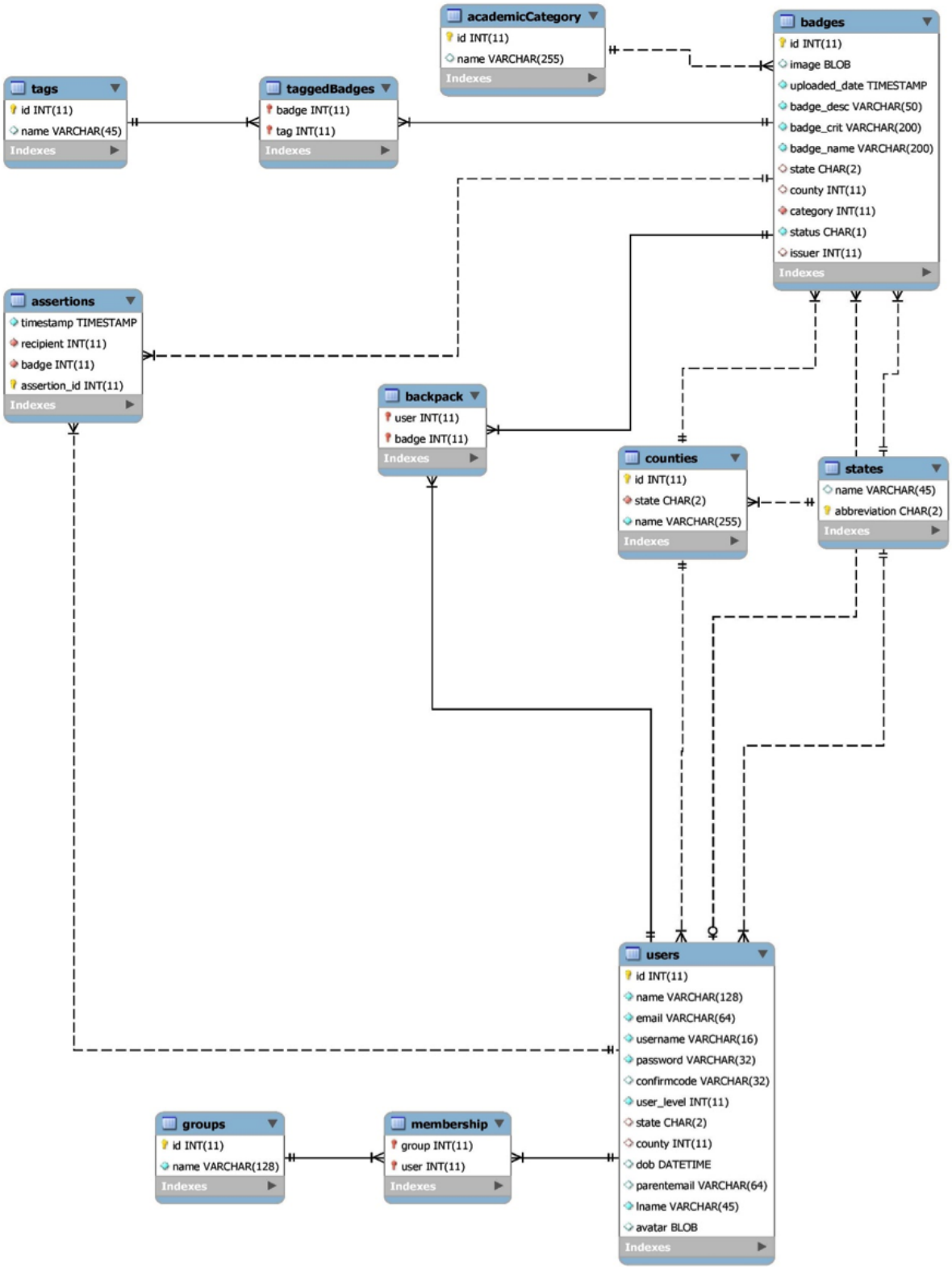


Figure 4.22: Protected Tables

4.10 Code Base

In order to develop the system, we used Adobe Dreamweaver CS6 as our development tool. We used MySQL workbench in order to create and maintain our databases. The whole applications were developed in around 12000-15000 lines of code including HTML, CSS, PHP and SQL. Following figure shows our directory, with all the files.

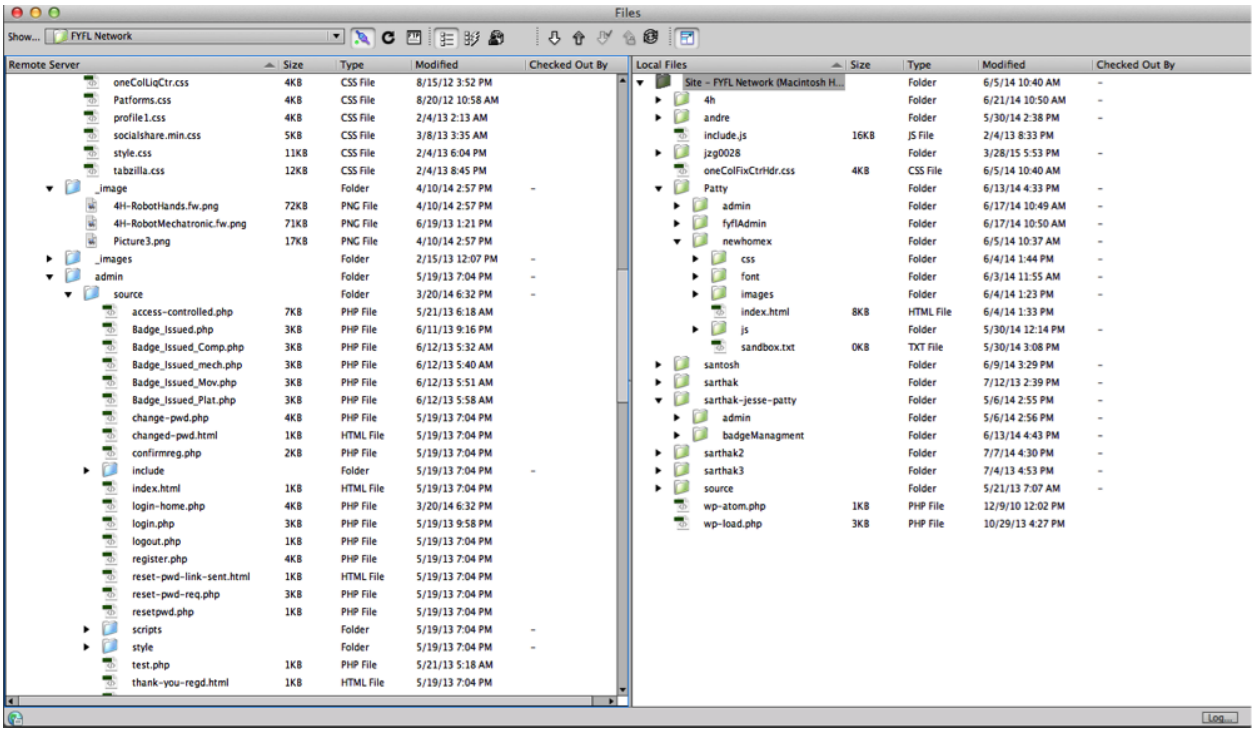


Figure 4.23: Remote Server View

Chapter 5

Experimental Design

This chapter presents the last phase of this study, a comprehensive evaluation of 4-H Digital badges that will be used by the members of communities in order to share best practices and its supporting principles. This chapter starts with the screenshots of how the system looks like, as a by product of design and development effort in phase 2, followed by empirical comparison between the system designed in phase II and the Drupal system developed in phase III.

Furthermore, screenshots from Phase IV, which forms the next iteration of the original system, and is based on one page design and AJAX, will be presented.

After that, we will run the system against all the test scripts generated in order to show that our system is secure against most of the SQL Injection and Cross Site Scripting attacks, which are prevalent in the current environment, followed by the hashing done in the database in order to maintain data integrity of the system.

Once the system has been fully exhibited, we will look at the results of the experiments conducted by using 4-H digital badges and how these results answer our research questions and the hypothesis, which were discussed in chapter 3.

After the conclusion of this chapter, we will be discussing the future work, which is possible to further improve the system, and add more functionality to the current system.

5.1 Phase II Results

This section exhibits the various integral facets, which thereby forms the core component of the 4-H Digital badges. We will start with the badge creator; the main purpose of badge creator is to load new badges into the system, along with the image and criteria to earn a

badge. After that we will investigate the Badge Directory, which is browser/searchable screen for current badges in the system and is the perfect guide for the learners to see which one is the correct badge to earn based on the skills required to earn the same. Furthermore, we will discuss Badge Pages, which contains an overview of what the badge is (a brief description), steps to earn the badge and what are the pre-requisite knowledge required to earn the badge. After the discussion of the above said topics, we will discuss the whole process of Badge issuances (how the badges can be earner and what involves earning a badge), followed by badges in the backpack (a place to keep all the earned badges). Following is the list of topics we will be exhibiting.

1. The Badge creator (Loading new badges)
2. Badge Directory
3. Primary Badge Pages
4. Badge Issuances
5. Badges in Backpack

5.1.1 Badge Creator

Badge creator is one of the primary features of 4-H Digital Badges, which offers the ability to the admin to create new badges. The process of creation of new badges involves uploading badge images, along with information listed below.

1. The state for which a particular badge belongs to,
2. County for that badge,
3. The academic category of the badge (Meta tags) which help learner to search the badge, instance of categories can be divided into different fields like science, robotics etc.

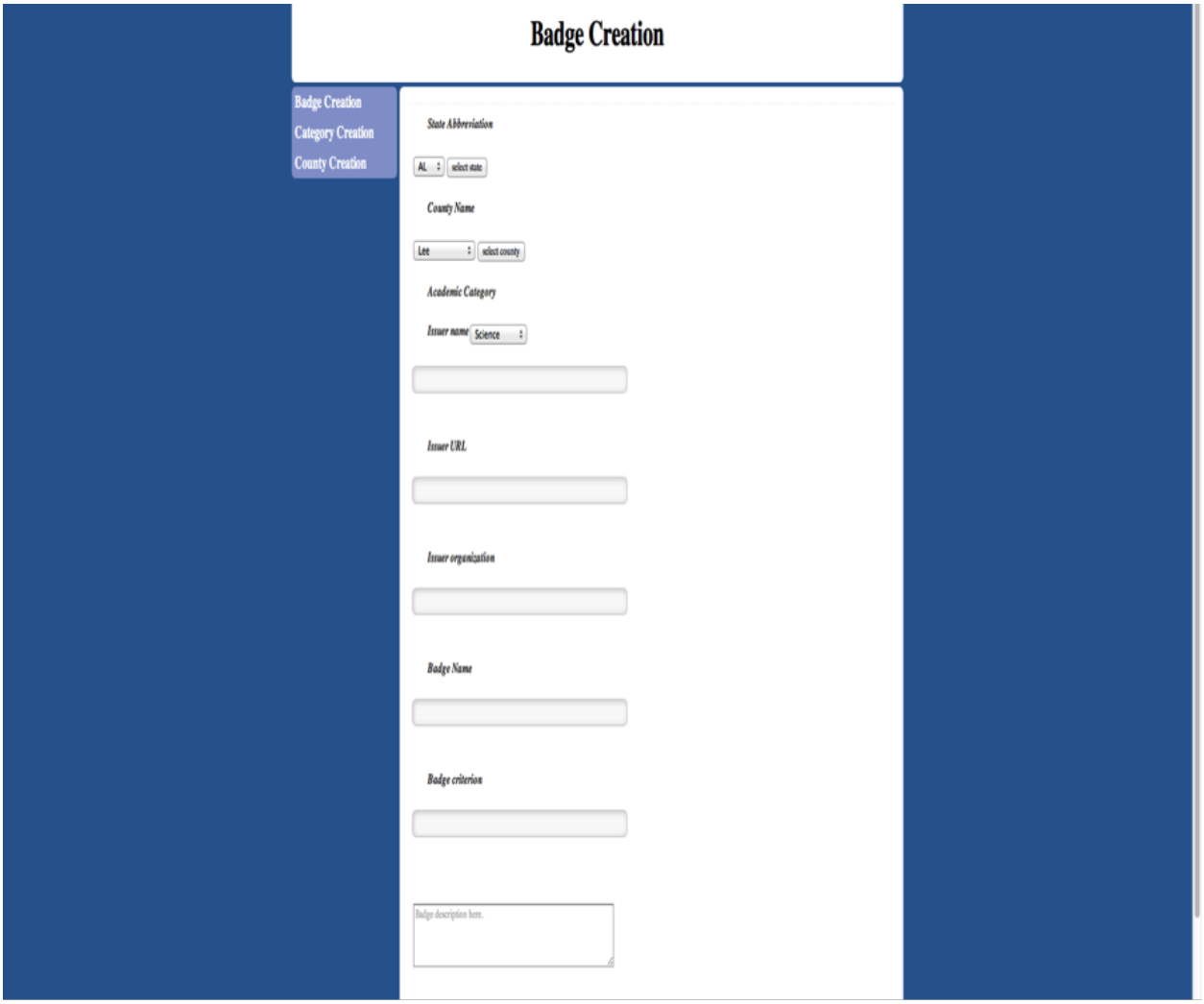


Figure 5.1: Badge Creator Used to Create Badges and set Badge Criteria

4. URL of the issuer

5. Description of the badge

6. Name of the badge

7. Criteria of the badge, which basically specifies the process to earn the badge.

Once the badge information is submitted, and all the required fields are validated, and upon final review it is created into the system and is available in the badge directory (discussed later) and is ready to be earned.

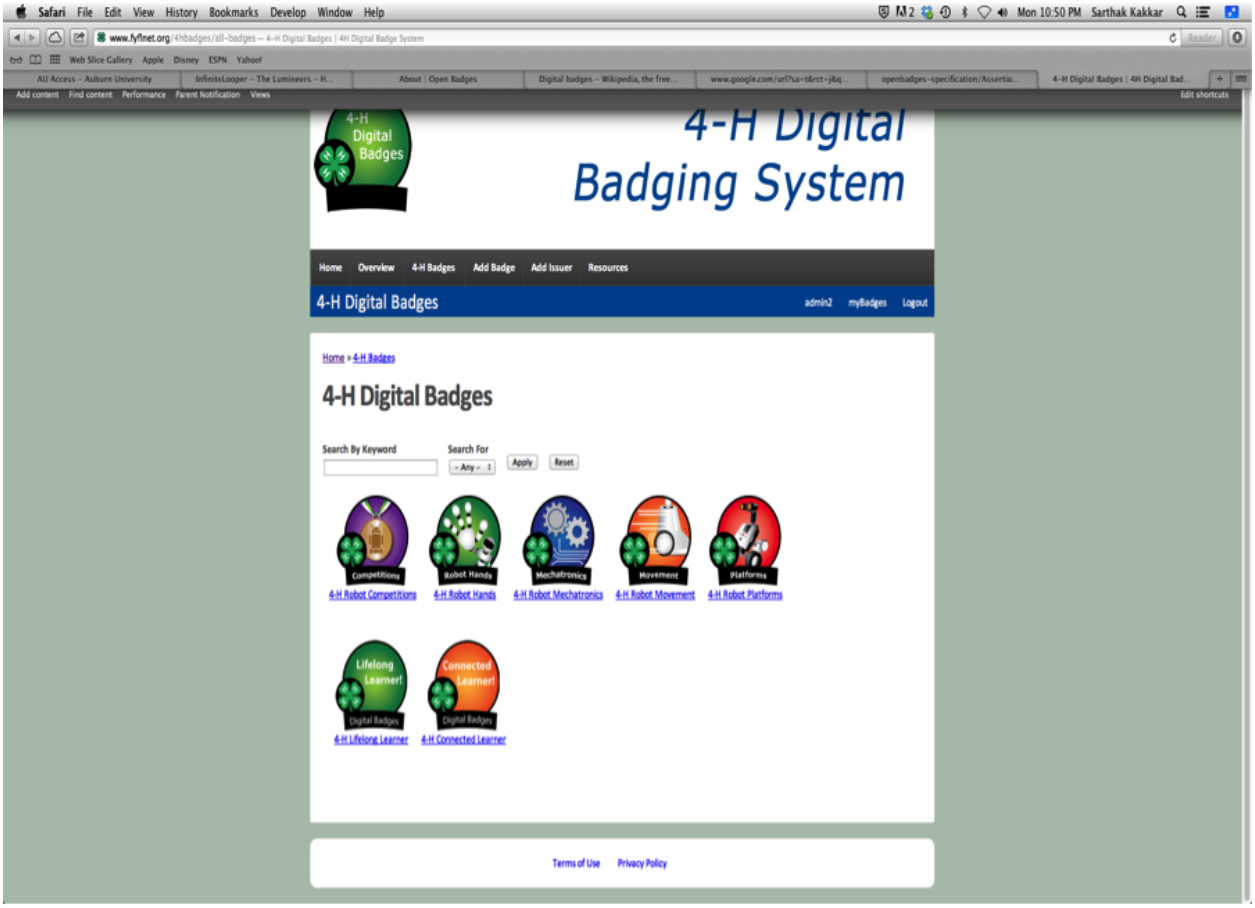


Figure 5.2: Badge Manager

5.1.2 Badge Directory

The badge directory can be considered as a storage place for all the badges currently active in the system, which is ready to be earned by current learners and/or facilitators. The system provides ability to search badges according to their categories, as a root structure to sort badges was designed because, there will be large number of badges eventually in the system, thereby making the search easy and more intuitive.

Figure 5.2 exhibits the badge manager with current active badges.

5.1.3 Badge Issuances

A badge issuances form is one of the most integral features of 4-H Digital Badges. Issuances of badges in the system are a two-step process.

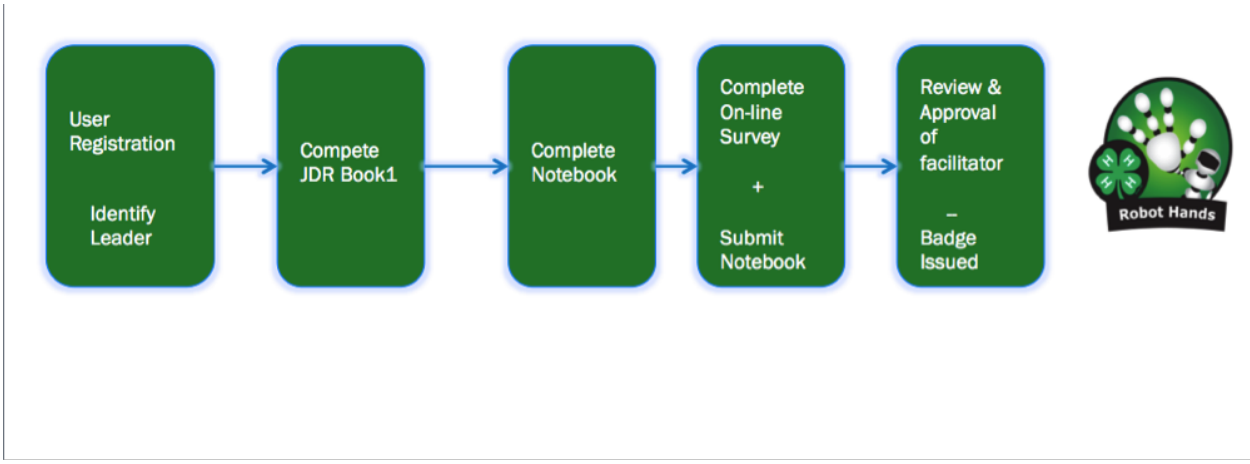


Figure 5.3: Step 1: Earning a Badge

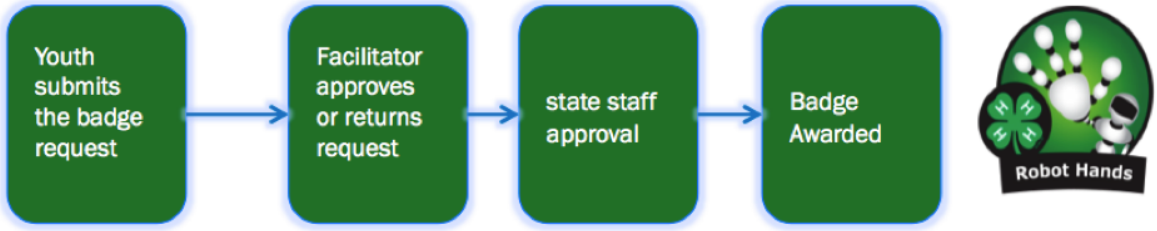


Figure 5.4: Step 2: Earning a Badge

The first steps starts with the user registration where the user identifies his/her leader, followed by the kind of badge he/she wants to earn. Once identified, the learner completes the required to course work which is associated with each badge. Upon completion of the course work, the learner is required to complete online survey.

Once the learner has submitted his response, it goes into the process of review and approval (which is done by the facilitators) and forms the step two of the whole process. The facilitator reviews the response of the learner for the specific badge, and after careful examination it leads to two cases. The facilitator awards a badge to the learner, or if considerate amount

of work has not been done, he returns the request with comments, as more work is required on it. Figure 5.4 briefs about the second stage of the process.

5.1.4 The Home Page

The home page forms one of the most integral parts of any application, as it is the face of application. It should contain all the important information, which triggers a motivation to further move the system.

4-H Digital Badges contains all the features which a home page should have, to name a few it has a self descriptive headline, followed by the benefits like what it does and why it matters. Plus the features, which provide more understanding of what is provided by the product, a simple navigation screen with self descriptive images and link for resources, which further describes the system if more documentation is needed. Figure 5.5 exhibits the home page of 4-H Digital Badges.

5.1.5 The Badge Page

Badge Pages for each badge currently in the system were designed. The badge pages contained the image of the badge, followed by its information (i.e. the badge title, Organization, Category, Level etc.). Along with that it contains the brief information of the badge and a brief over view of the process of earning a badge and the button to for the user to start the process of earning it. Figure 5.6 shows the badge page.

5.1.6 The Assessment

As mentioned above, for a learner to earn the badge, he/she needs to go through an assessment once he has completed all the pre requisites of earning a badge, which upon submission goes into the review queue. The assessment usually consists of 22 questions, both a mix of multiple-choice questions and three subjective. Figure 5.7 shows one of the badges assessment.

Figure 5.5: The Home Page

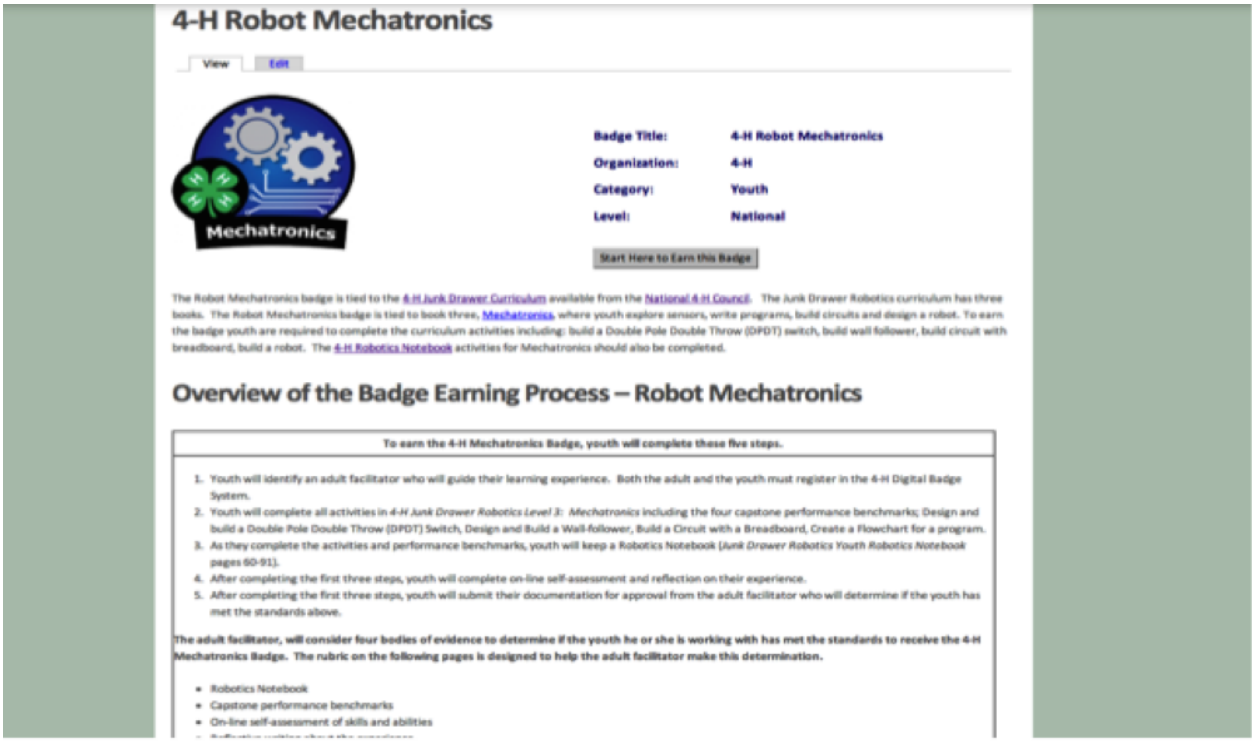
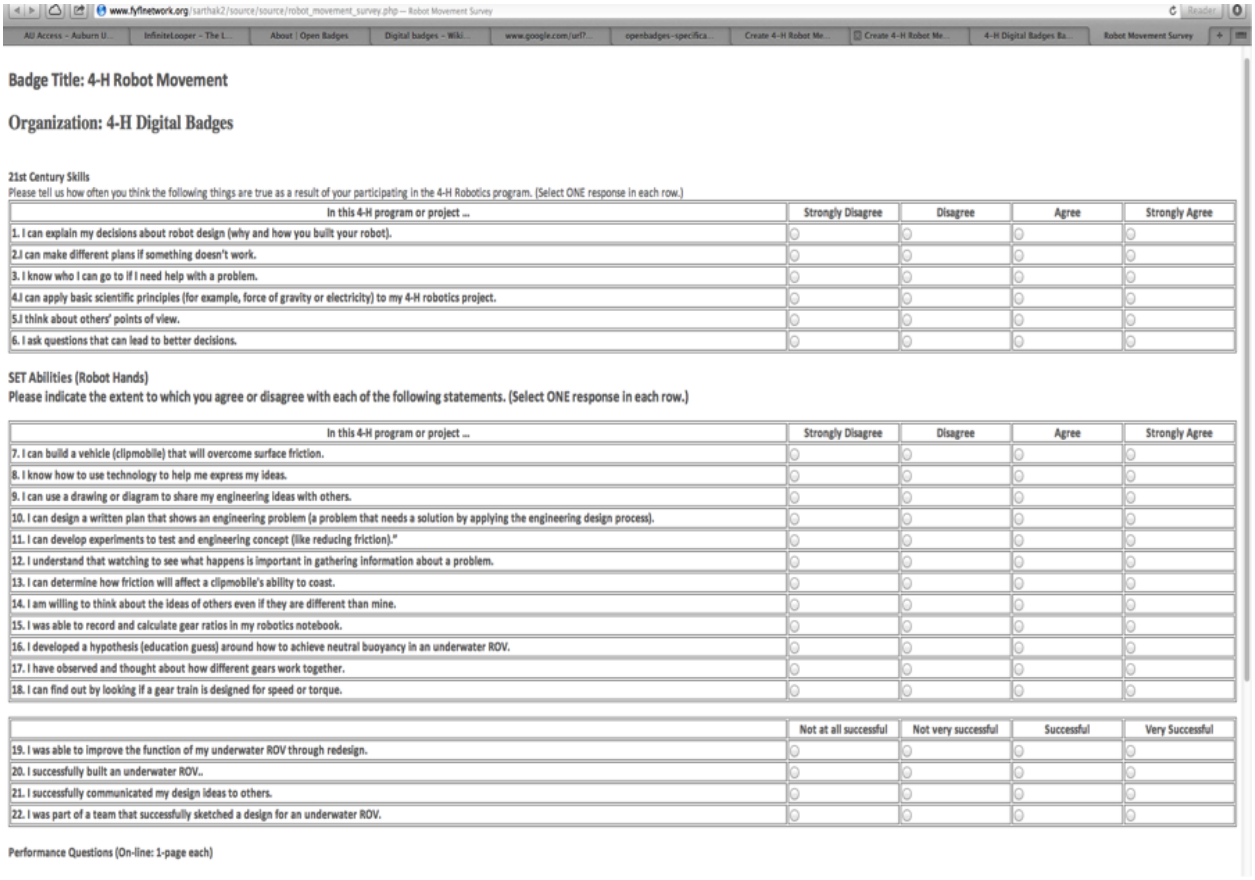


Figure 5.6: Badge Page



www.fyfinetwork.org/sarthak2/source/source/robot_movement_survey.php — Robot Movement Survey

All Access – Auburn U... | InfiniteLooper – The L... | About | Open Badges | Digital badges – Wiki... | www.google.com/url?... | openbadges-specifica... | Create 4-H Robot Me... | Create 4-H Robot Me... | 4-H Digital Badges Ba... | Robot Movement Survey

Badge Title: 4-H Robot Movement

Organization: 4-H Digital Badges

21st Century Skills

Please tell us how often you think the following things are true as a result of your participating in the 4-H Robotics program. (Select ONE response in each row.)

In this 4-H program or project ...	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I can explain my decisions about robot design (why and how you built your robot).				
2.I can make different plans if something doesn't work.				
3. I know who I can go to if I need help with a problem.				
4.I can apply basic scientific principles (for example, force of gravity or electricity) to my 4-H robotics project.				
5.I think about others' points of view.				
6. I ask questions that can lead to better decisions.				

SET Abilities (Robot Hands)

Please indicate the extent to which you agree or disagree with each of the following statements. (Select ONE response in each row.)

In this 4-H program or project ...	Strongly Disagree	Disagree	Agree	Strongly Agree
7. I can build a vehicle (clipmobile) that will overcome surface friction.				
8. I know how to use technology to help me express my ideas.				
9. I can use a drawing or diagram to share my engineering ideas with others.				
10. I can design a written plan that shows an engineering problem (a problem that needs a solution by applying the engineering design process).				
11. I can develop experiments to test and engineering concept (like reducing friction)."				
12. I understand that watching to see what happens is important in gathering information about a problem.				
13. I can determine how friction will affect a clipmobile's ability to coast.				
14. I am willing to think about the ideas of others even if they are different than mine.				
15. I was able to record and calculate gear ratios in my robotics notebook.				
16. I developed a hypothesis (education guess) around how to achieve neutral buoyancy in an underwater ROV.				
17. I have observed and thought about how different gears work together.				
18. I can find out by looking if a gear train is designed for speed or torque.				

	Not at all successful	Not very successful	Successful	Very Successful
19. I was able to improve the function of my underwater ROV through redesign.				
20. I successfully built an underwater ROV..				
21. I successfully communicated my design ideas to others.				
22. I was part of a team that successfully sketched a design for an underwater ROV.				

Performance Questions (On-line: 1-page each)

Figure 5.7: Assesment

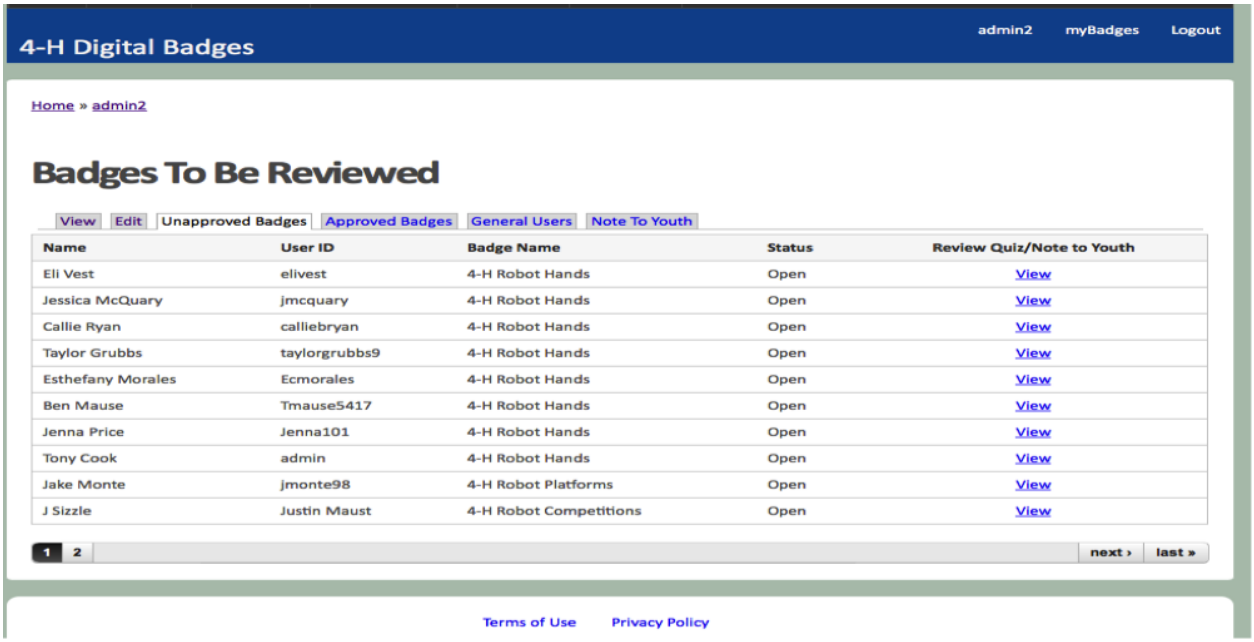


Figure 5.8: Pending Request Queue

5.1.7 Pending Queue

As explained above, upon the learner submitting the assessment it goes into the process queue, which can be viewed and reviewed by the admin. The admin can thereby view the person's response, and thereby approve it if substantial amount of work has been done. Figure 5.8 shows the request queue page and figure 5.9 shows the response page of the assessment (both forms the part of process of earning a badge).

5.1.8 The Backpack

The backpack is the place where the user earns all the badges and can keep and share it if they want. Upon clicking on the badge it displays the information such as Issuers details (i.e. Name of the issuers organization, its URL etc.) and the badge details. Figure 5.10 shows the backpack.

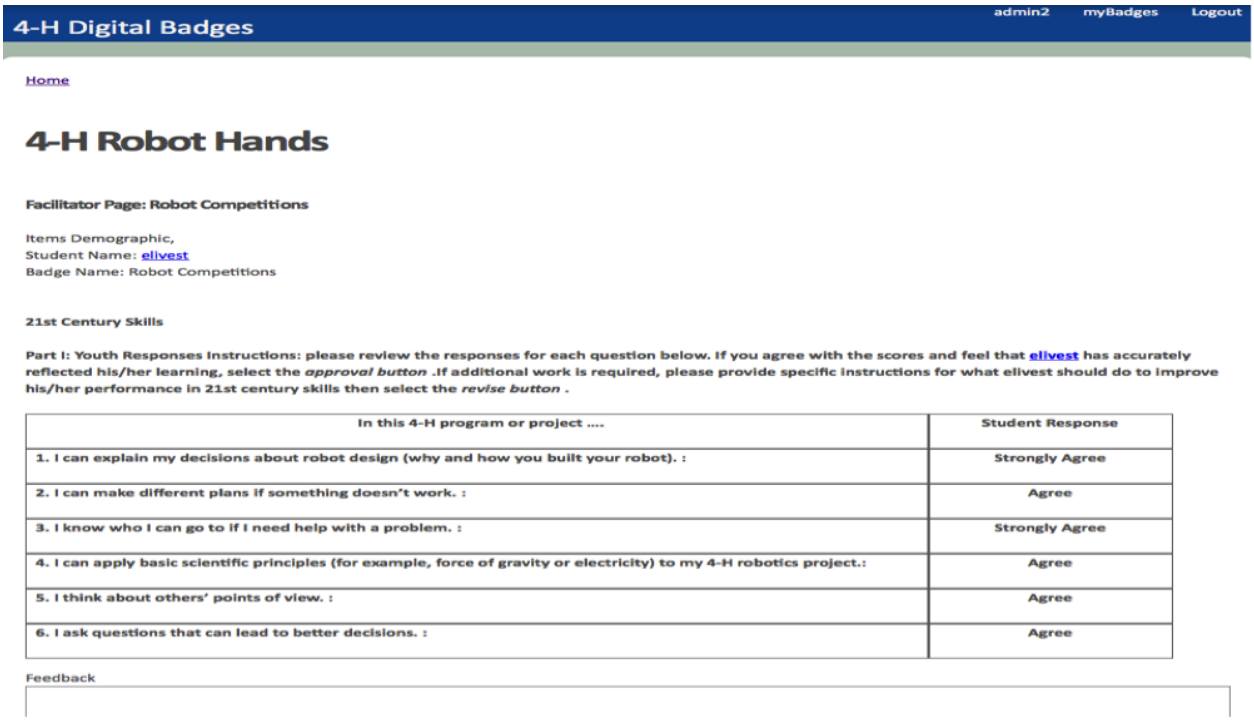


Figure 5.9: Response Page

Figure 5.10: The Backpack

5.2 Phase IV: Results

This section briefly illustrates the outcome of the application, which was developed with the new design (Single Page), utilizing AJAX. Figure 5.11 shows the home page of the application. Careful thinking was done to include all the important features, namely the description of the page, benefits of the system etc. in order to design the application.

Figure 5.11: Phase IV Homepage

5.3 Experimental Evaluation and Data Analysis

We conducted several field and pilot test to gain insight and understanding of how the end users (i.e. Novice learners and adult facilitators) would interact and perceive 4-H Digital Badges. We sought to support our hypothesis and that a collaborative environment is a useful caucus for user group to engage and learn through interactive learning. This work supports our hypothesis through usability ratings among potential users. Our goal was to answer the following questions:

1. Can informal learning be successfully supported within community of practice via the concept of Digital Badges?

2. Can a user perception about usability of online tools like 4-H Digital Badges affect adoption of a cyber tool if issues of technophobia, computer literacy etc. are not properly handled?

3. Is it the case that usability of a tool affects, the motivation of learners and adults in sharing best practices?

4. Can a system be successfully designed and supported which will eventually profess and sustain groups in a virtual world. A system that supports 4-H as an online community to share badges as accomplishments that provides secure social networking for K-12 Children?

5. Can a system be developed which easily resists attacks like SQL injections, XSS etc. and can easily pass the penetration testing?

6. Can 4-H Digital Application be more efficient, than it's Drupal counterpart?

In answering these questions, we provide data on the feasibility of the application for enhancing the learning experience. The outcome of the data could motivate other groups to design and develop online collaborative tools.

5.3.1 The Experiment Setup

The study was conducted in school located in two US states. These were categorized into two different pilot phase tests. The first pilot test consisted of 30 youth ranging from 9-15, along with 15 adult facilitators. The second pilot test consisted of 24 youth ages 10 to 18. The survey group was a collection learners (youth) and facilitators (Adults). There were 79 participants in total; table 5.1 shows the different age group involved in the survey. The main aim of the experiment was to examine functions of 4-H Digital Badges Site including the user registration and issuances procedures for youth and adults. The results will be discussed in the following section.

Table 5.1: Age Group Distribution

Age Group	Count
9-15	30
10-18	24
40-49	25

5.3.2 The Experiment Design

The experiment design of the study involved functions of the 4-H Digital Badges site including the user registration and issuances procedures for youth and adults. The experiment included a task list and a post-questionnaire to collect data.

5.3.3 Pre-Test and Post Test Questionnaire

The pre-questionnaire gathered general information about the participants to assess whether they met the criteria established for classification as both novice and content area expert. The post questionnaire was developed to measure perceived usability, appearance, and the requirements to earn a badge.

5.3.4 Procedures

The experiment began with completion of background pre-test questionnaire. This helped us make a distinction and divide our users into different age groups. After competition of the task, which consisted of user registration, and the whole process of earning a badge, the user completed a post survey.

5.3.5 Data Collection and Analysis

Two questions from the survey asked the users to give an overall site rating pertaining to the user interface and the accuracy of the information. The results showed that participants liked the tool and how the tutorial conveyed information to both youth and adults. Table 5.2 shows the results, with the rating from 1 to 10, 1 being the low and 10 being high.

Table 5.2: Usability Testing

	Youth: Mean(SD)	Adult: Mean(SD)
Futile ————-Accurate	7.96, (1.46)	7.40, (1.70)
Terrible ————-Wonderful	7.91, (1.38)	6.70, (1.96)
	10-point likert type scale	

Table 5.3 summarizes the two subtasks. We summarized task by performance in minutes. However looking at the summary we came to a conclusion that task were intuitive and provide a significant learning experience, thereby providing motivation to the youth to learn. It is clear from the date in table 5.2 and table 5.3 that most of the activities were not problematic and youth liked the overall system and realized that they could benefit from this system. However, in the case of Adults evident support for the application and the process of learning was not widely favorable.

Table 5.3: Usability Testing

Likert Item	Youth: Mean	Adult: Mean
Understanding the registration process	5.91	NA
Understanding requirement of badges	7.6	5.0
Plan to earn badges in future	8.4	5.20
Will badges provide motivation for learning	6.3	6.20
	10-point likert type scale	

5.3.6 Conclusion

In general, this study relies on a simple method to assess usability and accessibility of 4-H Digital Badges. Through formal testing we are able to draw conclusion that 4-H Digital Badges application is a promising tool for communities of practice to share best practices based on out analysis on the empirical data. The conclusion was made based on the participants' performance and subjective reactions.

5.4 Verification and Validation of the Application

In this section of the chapter, we will discuss various test scripts which were ran against our application, in order to make sure that the system is protected against basic website attacks like SQL injection and Cross Site Scripting. We will start with explaining our test scripts and the kind of attack it causes, followed by brief summary of how the system responded against these test scripts.

5.4.1 Test Scripts

In this section, we will the XSS and SQL injection test scripts we used against our system in order to test the robustness of the application.

Test script 1: The following JavaScript will send the cookies of the host machine to attacker machine when executed by a browser.

$< script >$

$image = newImage(); image.src =$ "$http://attacker.IP.Address/?cookie =$ "$+document.cookie;$

$< /script >$

Test Script 2: The following JavaScript once ran on the browser, will create an infinite loop of alert.

" $>< scriptlanguage =$ "$javascript$" $> window.alert($"$here$"$); < /script >< inputname =$ "$garbage$"

Test Script 3: The following test script is the perfect example of SQL injections, which can give the list of all the users in the database.

Select * from user_auth where name= 'test_user'

And password = " or 1 = 1–'

Test script 4: The following will javaScript will show the contents of your cookie as you mouse over the work "Security":

$< SCRIPTLanguage =' JavaScript' >$

$<! - - JavaScriptFollows function winopen(){$

$msg = open("","NewWindow","toolbar = no, location = no, directories = no, status = no, menubar = no, scrollbars = no, resizable = no, copyhistory = yes, width = 400, height = 260"); msg.document.write(" < HEAD >< TITLE > Welcome < /TITLE >< /HEAD > "); msg.document.write(" < CENTER >< h1 >< B >< script > alert(document.cookie) < /script >< /B >< /h1 >< /CENTER > "); \}$

$//JavaScriptEnds - - >$

$< /SCRIPT >$

Move mouse over

$< ahref = "URL" onMouseOver = "winopen(); returntrue;" > Security < /a >$

5.4.1.1 Results on Implementation of Test Scripts

The test scripts listed in section 5.4 were run against the following badge pages. Initially the system failed a lot of the attacks test scripts, it had some weaknesses and after the steps taken which were discussed in chapter 4. Table 5.5 supports our point, as results show that most of the system resisted these security attacks, and thereby answering our research question that we are providing a secure application and our hypothesis as well.

Table 5.4: List of programs tested

index.html	badgemanager.php	profilepage.php
login.php	earner.php	badgedesc.php

Table 5.5: Summary of the Results

Program	Script 1	Script 2	Script 3	Script 4
index.html	NA	NA	NA	NA
badgemaker.php	Pass	Pass	Fail	Pass
profilepage.php	Pass	Fail	Pass	Pass
Login.php	Pass	Pass	Pass	Fail
earner.php	Fail	Pass	Pass	Pass
badgedesc.php	Fail	Pass	Pass	Fail

5.4.2 Speed and Efficiency Drupal vs. Original

In this section we will discuss the speed and efficiency of the original system and Drupal system. In order to measure the time it takes to load pages, we used Mozilla Developer Edition to measure the time for the same pages, which were present in both the systems. Table 5.6 shows the differences in the efficiencies, when tested on different programs.

Table 5.6: Summary of Efficiencies

Program	Orignal System: Time (s)	Drupal System: Time (s)
Earn your first badge	1.9	4.73
Home Page	3.5	4.288
Resource Page	3.1	4.64
Registration Page	1.866	5.14

Very evidently the original system is faster and more efficient that the Drupal system. This validation supports our research question and our hypothesis of the system being faster than the Drupal system.

Chapter 6

Conclusion and Significance

The intent of FYFL (For Youth For Life) application was to provide an easy to use, cost effective and scalable collaborative system in order to facilitate learning and sharing best practices across communities in line with the Computer Supportive Collaborative Work. The research was focused on providing a solution to the world of 4-H world to move away from paper based traditional methods of learning, collaboration to the modern age of computers and e learning. 4-H digital badges provided the solution to move from the stone age to the modern age. 4-H Digital Badges is an application described as an online skill, quality and accomplishment recognition and validation system.

Phase I of this research was to design architecture of the system, which should encompass all the pre-requisites described in the above section. Careful thinking and analysis was done to architect the system. Phase II of the research was to develop the system, along with the challenges surrounded by the changing OBI compliancy, resulting in modifying the design to maintain compatibility. Once we got pass the development phase, we moved onto our phase III, which was outsourcing the product to a different company due to slow development of the original system (lack of resources). The process helped in understanding the process of requirement gathering, and communication in an agile development environment.

Phase IV of this research was to prove the viability and purpose of the system, this was achieved by conduction various pilot/field test among the target audience in two states of the US. In addition to these studies to improve the User experience for the next iteration was made and analysis was made on the current security threats to the application.

The significance of this research was to design and develop a collaborative application to support communities of practice members involved in informal learning, by providing an

environment to share best practices. The study also examined ways to inspire the learner to gain more knowledge by the skill recognition methodology. The study also focused on examining key techniques to be implemented during the development phase, in order to prevent security vulnerabilities.

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