A Collaborative, Adaptive-Based Approach to Informal E-Learning Technology Design

by

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ABSTRACT

Significant innovations in learning technologies are encouraging individuals, especially high school students, to seek enrichment learning opportunities that they normally are not able to take advantage of due to the limitation of traditional classroom offerings in low-income school districts. With the increase in learners seeking alternatives to traditional classroom learning and the capacity to expand access to knowledge and information through the Internet, there is a need to provide tailored learning experiences with collaboration that is usable and secure. Web-based learning environments allow courses to be customized to the learner's current knowledge as well as allow students to connect with other students outside of their current setting to capitalize on one another resources and skills. Another aspect of learning technologies is that they provide an environment which enables users to access information at any time and stay connected as long as they desire. Web-based environments to support K–12 educational needs have rarely been fully and satisfactorily developed with specific attributes such as learning and adaptability.

This work reviewed the design and implementation of various learning technologies and environments and explored adaptive-based algorithms to support the real-time presentation of user content based upon user selection. The purpose of this research was to address the need of increasing course options within informal learning environment through the development of web-based learning environments. This research produced system design guidelines for a collaborative and adaptive-based application that supports informal e-learning for K–12 students.

Increasing adaptability and collaboration within web-based educational environments allow the trajectory of learning to be customized to each student so the core of the subject matter being taught can be mastered by the student. Learning is improved through this system personalization which makes it a more meaningful and enjoyable experience for the student. Based upon empirical studies of an online web-based environment called ChemiNet, it showed that learning depends on how well the student understands the concepts and are satisfied with the aesthetics of the user interface. After observing users using the ChemiNet application, it was realized that more individualized instruction is needed in order to keep each student focused on the material being taught. Individualized instruction and providing more real-like feedback occurs in a traditional classroom setting was an area survey participants felt the ChemiNet application lacked. In order to address the concerns and to achieve a more viable learning environment, investigations in adaptive computer-supported collaborate learning (CSCL) was explored. This research paradigm allowed us to identify system designs that can support collaboration and adaptability in informal e-learning environments. The primary focus was to create an environment that uses those system designs where students, ages 13–17, can informally access course information on different topics, specifically STEM, targeted towards high school students. Ultimately, supporting low-income school districts by having a secure and usable environment that allows students in their area to enroll and take enrichment courses that are not offered in the traditional face-to-face classroom environment. This research focused on online learning tools, web-based learning environments, CSCL, usability, and virtual learning environments.

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CHAPTER 1: INTRODUCTION

Along with a proliferation of emerging multimedia technology, the Internet is making a profound change in the way students learn by transforming the traditional educational landscape into a virtual learning space. Today, more and more learning opportunities are being offered through web-based applications because of the convenience they offer both the student and teacher, including allowing students access to course material at any time and giving teachers the ability to share content with students outside of their geographical area. Web-based course offerings, utilizing the latest technology, have the opportunity to allow an unlimited amount of students to access course material. Therefore, the key role technology plays in classrooms contributes to the increase in informal learning across the nation. This can be seen across all educational levels from elementary to doctoral studies. With the demand for such web-based learning environments, there needs to be an identified framework to support the usability and security of these environments for teenage users.

Web-based learning environments (WLE) generally refer to an Internet-accessible application that enables user interaction with learning tools. These learning tools can display content, generate quizzes, show downloadable resources, and display activities for students to interact with while partaking in a course. A WLE, which are similar to Virtual Learning Environments (VLE), is not a static web-site that displays content alone.

Human Computer Interaction (HCI) researchers have focused on how students interact with computer technology for learning purposes and ways to make that interaction better. Over the past few years, the concept of Massive Open Online Courses (MOOCs) has become very popular across the web (Calle-Jimenez, T., Sanchez-Gordon, S., Luj, S., x00E, & n, 2014). MOOCs are usually publicly accessible environments with no fees. These virtual learning spaces provide course content in several different layouts on multiple types of devices enabling these environments to meet the needs of students from different backgrounds, skill levels and locations. A MOOC is an advanced type of VLE or WLE in which a larger number of students can view and access content at once. MOOCs, such as Udemy and Coursera, can normally teach over 100,000+ students at the same time in the same course. As a result, MOOCs are among the most effective and efficient ways to deliver educational content due to the flexibility and the wide variety of courses that can be offered at once (Alzaghoul & Tovar, 2016).

Given the development of MOOCs, researchers in human-computer interaction seek to understand how to incorporate technologies that monitor students' attention span by creating novel design spaces (Szafir & Mutlu, 2013), focusing on the domain of adaptive-based and collaborative systems. With the widespread use of the Internet on various devices (smartphones, tablets, laptops, etc.), there is a need to design user interfaces for applications that enable the effective and efficient use of technology parallel with a reduction in the possibility of user dissatisfaction due to confusion or frustration. The design of the system should be centered around the goals of end-user population of the system rather than the business goals. This will ensure a high level of usability is achieved within the system, ensuring that it is easy to use and learn by K–12 users.

Designing, implementing and deploying learning environments can minimize the digital divide between educational disparities in low-income areas. Large-scale learning systems such as course management systems have evolved in both scale and usage over the past decade. With this evolution, research in adaptability and intelligence in terms of learning systems has been prevalent. However, with the recent appeal of social media, collaboration has become one of the main points of interest in eLearning, which has generated research areas in Computer-Supported Collaborative Learning (CSCL) (Magnisalis, Demetriadis, & Karakostas, 2011). However, there has been little focus in HCI and CSCL on collaboration methods of learners within web-based learning environments and/or MOOCs. This research has mainly focused on higher education instead of K–12 education. Hence, this research focuses on increasing the availability of collaborative and adaptive-based e-Learning environments in support of K–12 education. A benefit is providing a more collaborative environment, so K–12 students can share ideas and ask questions as well as enable K–12 teachers to incorporate more team-based assignment in distance learning courses. The study focuses on the use of web-based technologies to support adaptable, scalable, and efficient learning and collaboration architecture in a user-friendly method demonstrating greater ease of use compared to most CSCL systems. An environment was created as a contribution to this research that supports a collaborative and adaptive-based informal learning space. The environment encourages K–12 students to take advantage of enrichment courses and collaborative with peers for support in the initial phase of the study.

1.1 Informal Learning

Access to computers and the Internet is widespread amongst middle and high school students from a wide range of places. During the preliminary study for this work, the researcher found that 100% of participants surveyed had access to a computer at school, home, library, or another location. Providing options on the web to allow students to pursue their interest as well as improve their technological, mathematical, engineering and scientific ability will benefit American society. With the wide variety of career paths for high school students, not all learning options can be provided within a traditional classroom. In order to meet the demand and offer a sufficient variety of topics to students, an umbrella term was created called informal learning. While informal learning occurs in many different ways, such as through textbooks, this work built a web-based learning environment to support informal learning.

Informal learning covers a broad range of learning types. In this work, the term *informal learning* refers to self-directed learning wherein the student determines the information he or she wants to learn and at what pace. Since informal learning is also known as self-directed learning, it is critical that, if this learning will occur over the web, an interface should be intuitive and user-friendly, ensuring that users are not overwhelmed or frustrated with completing actions within the environment due to usability issues. Resolving usability issues and providing a positive user experience helped students concentrate on the material as opposed to application troubleshooting. This work addressed usability concerns within web-based learning environments and deliver a set of design guidelines for these types of environments so that informal learning can be more conducive in an online delivery format.

1.2 CSCL and Designing Learning Systems

With the popularity of social media, much research has focused on CSCL and adaptability to design learning systems according to a user's needs. This research area has expanded far beyond the naïve concept of digitalizing and disseminating classroom content to a more advanced delivery method that encompasses a system design architecture that embodies intelligence as well as adaptability. This research focuses on adaptive CSCL in relation to (a) sharing instructional material from two perspectives: student-to-student and teacher-to-student, (b) usability of web-based technology and the effects on novice computer users: (i.e. Human Computer Interaction of system interfaces) and (c) adapting to user selection and system input. This research also examines how Information and Communication Technologies (ICT) can support informal learning amongst K–12 students, a population that has been swarmed into a highly social media and technology era. ICT has led to the development of several web-based multimedia technologies (e.g. blogs, wikis, video conferencing and images (Claros & Cobos, 2012; Law, Nguyen-Ngoc, & Kuru, 2007) that promote collaboration on the web (Phielix, Prins, & Kirschner, 2010).

1.3 Research Goals and Contribution

As a contribution of this dissertation research, a collaborative, adaptive-based system prototype was developed and evaluated by students seeking informal learning opportunities. Adaptability in the context of this work has three parts: (a) course content adaptability, where a user's interest in material is taken into consideration which will allow the same material to be presented differently based upon the individual learner; (b) assessment adaptability, where a user's response to prior question will determine what type of information will be displayed and how it will be displayed; and (c) user-directed feedback, where feedback on user performance is individualized to increase performance within the learning environment. The study investigated and focused on adaptability, usability and security issues that affect web-based environments to ensure that the designed architecture meets usability standards for web-based systems as well as provides a minimum level of security for the safeguarding of personally identifiable user information and preventing the falsifying of information. Human-Computer Interaction (HCI) techniques and design guidelines was used to provide an application that is easy to use and user-friendly for novice users. Security techniques stated in ISO-17799 (“ISO/IEC,” 2013), was taken into consideration when designing a secure CSCL system. In order to evaluate the system interfaces and security, the researcher gathered feedback from the user population using online surveys as well as the cognitive walkthrough method. The researcher evaluated feedback from the user population on problems and limitations of the initial design requirements of the system for current deliverables. The usability experts, K–12 teachers, and students were selected as the initial targeted population to test and validate the system before final deployment.

1.4 Motivation

With the rapid increase in ICT, the traditional landscape of education (i.e., face-to-face) has transitioned into a more virtual setting and has made the concept of eLearning more acceptable among this generation of educator and learners (Aljenaa, Al-Anzi, & Alshayeji, 2011). This acceptability has seen the launch of several web-based learning environments such as Khan Academy (“Khan Academy,” 2013) and BrightStorm (“Time-saving Homework,” 2013). These websites provide video-based learning on several topics ranging from college readiness exams such as American College Testing (ACT) to more leisure-focused topics as gardening and financial planning. While these sites provide lots of valuable information, they lack the ability to allow users to collaborate with others in viewing course materials as well as adaptability. Hence, CSCL has many unexplored benefits in adaptability and the incorporation of multimedia technology. For example, through CSCL and the rise of new ICT K–12, students and educators can be encouraged to explore, absorb, and share knowledge among each other where the environment conforms to the user instead of the user conforming to the environment. Usability is a key factor when evaluating web-based learning environments. This work designed, evaluated, and validated a learning space that can be used to encourage the sharing of knowledge as well as provide adaptive feedback which benefited the learner’s overall performance and satisfaction with the material being explored through adaptive CSCL and ICT. Through surveys about the web-based online tool/virtual community prototyped in the HCI lab, the researcher validated the need to incorporate a tool to support K–12 education by providing a virtual community to support informal learning by students from various backgrounds and cultures. The research findings highlighted the untapped benefit of collaborating through the CSCL tools as well as the hindrances compared to traditional methods. These benefits include:

- Motivation to collaborate
    - Members of an informal learning environment will build a sense of responsibility by feeling obligated to share knowledge with other students as well as a need to reach out to other students to support their understanding of the material being presented. In due course, each student will learn to share knowledge and provide insightful feedback to others in the course.
- Efficient access to information
    - Members of an informal learning environment can access information and other resources easily without the restriction of time and place, unlike the prevalent face-to-face collaboration system. In addition, the permanency of records on shared information as well as the independence of time and place to access information will allow members to learn and complete tasks at hand remotely. This will also eliminate the fear of starting from scratch when the need for a new course arises and encourages students to work at their own pace which allows them to stop or slow down if other more imperative tasks/work arise.
- Possibility to increase written communication skills
    - There is a high possibility for students participating in the informal learning environment to learn how to communicate more effectively through writing since the main form of communicating with each other and building teams will be through written communication (i.e., e-mail).

1.5 Research Approach

In order to answer the proposed research questions, the researcher designed and implemented an environment where K–12 students can learn a variety of STEM subjects in a fun and engaging way that is not restricted to a brick-and-mortar facility. The researcher identified K–12 students and teachers as the initial subgroups who will benefit from collaborative interaction with respect to participating in web-based informal courses on various topics. Students were identified because they are the main population who will be interacting with the course user interface. The main criteria for choosing members to participate in the study is voluntary acceptance of teachers and schools to participate. Students must be willingly to sign up to participate in the web-based learning environment developed to foster collaboration and learning a particular subject utilizing this application. Participants provided feedback on its usability and how easy it is to use by novice users for collaboration purposes. This web-based tool is assumed to be a framework model of complementary between collecting quantitative and qualitative data on web-based learning among students. In the long-term, the study will focus on K–12 teacher collaborating with each other and sharing learning techniques and can extend to sharing and re-using educational materials between teachers.

This study focused on various subjects in the first phase of this work. The aim was to study how an informal learning environment can provide a friendly and secure experience for K–12 students in the United States, which has a more decentralized educational structure.

1.6 Dissertation Organization

This dissertation is organized as follows. Chapter 2 provides a review of the literature as well as an introduction to the fundamental research areas that underlie this works such as Human Computer Interaction (HCI) and Computer-Supported Collaborative

Learning (CSCL). Following the introduction are topics on Educational Disparities, Web-Based learning technologies and tools, and educational technology as well as discussions on Massive Open Online Courses (MOOC) for teaching and learning. Chapter 3 defines the methodology, which includes the research questions, a detailed description of the propose implementation. Chapter 4 presents the preliminary work done in this area and the results from the preliminary study. Chapter 5 presents another preliminary study done in this area that focused on the teacher user experience of educational web-based applications. Chapter 6 presents the final system implementation based upon the work done in the two preliminary studies, along with detailed user design guidelines for informal web-based learning environments. Finally, Chapter 7 provides the final analysis and conclusion.

CHAPTER 2: RELATED WORK

The research in educational adaptive learning technologies was predominantly informed by work within HCI, Software Engineering, Machine Learning, and Computer-Supported Collaborative Learning (CSCL). Additionally, the research focused on social status learning disparities within the United States (US), as informed by the research in the educational domain.

2.1 Low-Income Communities Educational Disparities

Many low-income communities face disparities when it comes to receiving access to quality educational tools and resources, due to low-income communities receiving less funding than their wealthier counterparts (Education, 2011). With low funding, school districts are unable to provide access to extracurricular courses in various subject areas to their students. Studies have consistently shown that low-income students have less access to a high-quality curriculum (Darling-Hammond, Zielezinski, & Goldman, 2014). Promoting the use of web-based learning systems within low-income communities is a way to reduce the educational disparities in these communities. Students in low-income communities need extra support as well as additional resources that can broaden their exposure to various concepts and learning opportunities (Education, 2011). In prior years, state educational leader through federal funding have setup such programs as Title-I to help provide these additional opportunities but no major impact has been made. Previous studies focusing on the effectiveness of educational learning tools on low-income students demonstrated positive results for students who were committed to using the tool on a regular basis for learning (Frias-Martinez, Virseda, & Gomero, 2012).

2.2 Technological Approaches to Promote Learning

2.2.1 Educational Software

Technology is changing the way we conduct business, how and where we learn and gather information and even our everyday lives. Computers, tablets, cellphones, smart-watches and other mobile devices are influencing our society and increasing the possibility of allowing learning to take place in informal settings. In today's thriving technological age, many secondary school systems are using their limited financial resources to purchase educational software ("Survey: School budget cuts even worse next year," 2010). The software can come in many forms. Most educational software companies are moving towards providing web-based solutions, which are not restricted to distance education. In many cases, this software can be used as part of classroom curricula to teach core objectives in a particular subject area or to reinforce concepts for standardized tests. The software application can provide information that can serve as an introduction to a lecture the instructor plans to teach, the actual lesson or a post-review of a lesson. Many software applications provide several examples in which teachers can use to reinforce some of the concepts by providing additional examples. In addition, the educational software could be used to help more advanced students explore concepts further while the teacher focuses on bringing students with difficulties up to standard.

With educational software being popular over the last few years, new web-based products are becoming available such as Massive Open Online Courses (MOOCs) (Alzaghoul & Tovar, 2016). These learning environments can serve a great number of students at once. This has become popular because of the current cloud infrastructure, which has enabled these systems to rapidly expand, based upon the number of users and the amount of content being offered (Nat et al., 2017). These technological advances are encouraging many educators to look at what can enhance the learning process and allow for an atmosphere of continuously learning with material available.

The emergence of new technologies targeting education is increasing in today's market (Klopfer, Osterweil, Groff, & Haas, 2009). Therefore, many secondary schools are integrating technology into the classroom each year by placing smartboards, which are interactive whiteboards, or additional computers terminals inside the classroom. Teacher and educational leaders are attending educational conferences and events to seek out new software that can be used in the classroom to help them meet their state standards. Furthermore, training is also provided at conferences and conventions so teachers can learn how to use the software effectively. County leaders are setting goals to increase the number of computers in the classroom in their school districts with access to the Internet (Stahl, Koschmann, & Suthers, 2006). With additional funding and classroom-ready resources, educational software adequate for today's generation of high school students needs to be developed.

Educational software provides a collaborative and dynamic learning experience for all involved, especially the students (Cao, Crews, Lin, Burgoon, & Nunamaker, 2008), serving as a learning environment where students can improve their knowledge in the software's target area of study. It also provides a self-learning and adjustable pace environment for students to explore and investigate topics discussed in the classroom further. Therefore, educational software can support the material already being present in a traditional format by the teacher.

Many children become easily distracted or disinterested when teachers are presenting material in the traditional way. Therefore, it is important to integrate technology into the lessons because it can act as a "hook that gets students to participate" (Blumenfeld, Kempler, & Krajcik, 2006). For example, if a teacher is presenting different kinds of elements from the Periodic

Table on the board through a regular overhead projector, students may become very overwhelmed and stop absorbing the information due to a lack of interaction with that information. A lesson presented on the computer, where students could interact with the content by clicking on different elements and controls, is more effective because interaction produces a better learning experience for the student. Not every educational application may be effective for each class; therefore, the teacher's responsibility is to request the most effective software that meets the instructional goals for the course.

2.3 Web-Based Learning Environments

A learning environment can be categorized as "computer-based environments that are relatively open systems, allowing interactions" that provide an array of resources for a particular domain (Piccoli, Ahmand, & Ives, 2001). Interaction can come in many forms, such as interaction with content, interaction with peers, and interaction with instructors (Swan, 2003).

The World Wide Web ("web") is a dynamic environment where information is interlinked. It has seen rapid growth in the number of available educational websites (Furner & Daigle, 2004). However, only handfuls are user-friendly and valuable based on the information being disseminated from that particular site on the web. The web has been used as a crucial marketing strategy in many industry businesses but is now expanding into education, particularly at the collegiate level. Many colleges now offer distance learning course or courses with web-based instructional support applications to their students, such as Blackboard, Moodle (Figure 2.1) and WebCT (Nat et al., 2017). These applications are effective for disseminating particular course information, such as Word documents and PowerPoint version of lecture material. They are less effective in providing an interactive learning environment, but rather "only digital reincarnations of poor face-to-face learning environments and practices" (K., 2005). However, there is a need for more direct learner interaction with content over the web.

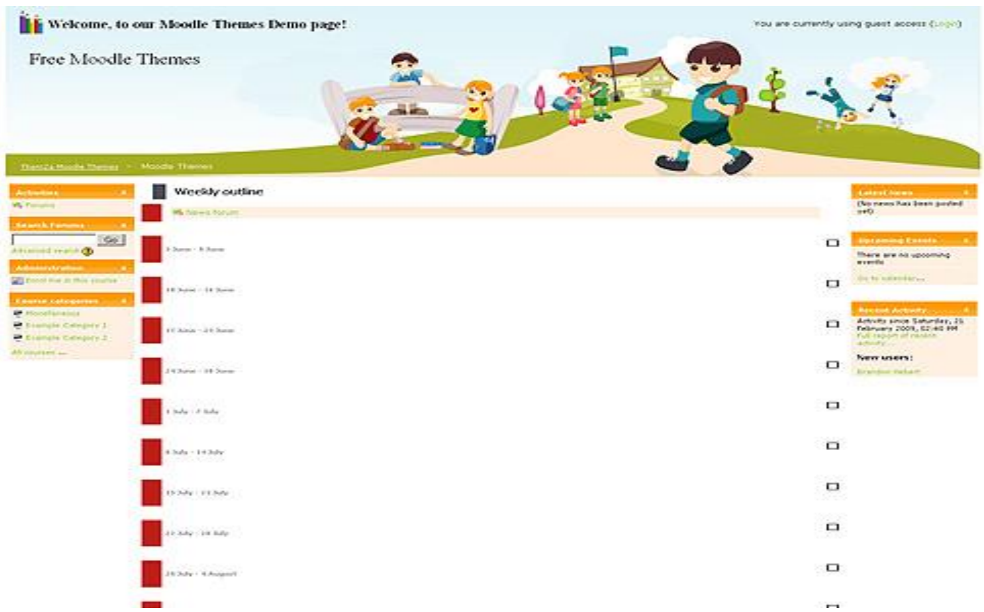


Figure 2.1: Sample Moodle Interface for Primary Education

The Internet comprises many web-based learning environments (WLE), offering students an array of options to choose from to gain knowledge on a particular concept. Some options include games, simulations, chat environments, and drill and practice. While many meet the first need of equipping students with the proper knowledge, they fail at preparing students to work in an environment more structured toward their current curriculum or they provide only static material.

With advancements in software development tool and technologies, WLE began to appear on the web. In previous years, research has focused on several conceptual frameworks for WLEs; however, researchers remain uncertain concerning the effectiveness of these frameworks, in particular how interactivity affects the quality of student learning (Swan, 2003).

The designs of these types of environments are crucial for it to be an asset to teachers and students (K., 2005).

In the 2001 No Child Left Behind Act, Congress placed a vital task upon the U.S. Department of Education: ensuring schools that are purchasing educational software with federal monies could only purchase the product if the software development company can provide documented research results that demonstrate the product effectiveness in increasing students' academic achievement (Johnson, 2003). Federal law requires that software is proven effective before the school system can make a purchase, so educational software development companies are spending time and money to produce quality software for students. Researchers concerned with the effectiveness of online education software have identified ten concepts that outline what an application needs in order to increase learning (Swan, 2003):

- [Teachers] acting as facilitators
- Use of different presentation styles
- Multiple exercise
- Hands-on problems
- Learner control of pacing
- Frequent testing
- Clear feedback
- Consistent layout
- Clear navigation
- Available help screens

These concepts can help teachers select well-designed software for their classroom so it can be used as intended and have an impact on the students' learning process.

2.3.1 Impact of Web-Based Learning Environments on Classrooms

Introducing well-designed educational technology into the classroom will most definitely have a positive impact on classroom instruction because it will improve the overall learning process of the students (Darling-Hammond et al., 2014; “The Research Basis,” 2008). One of the main benefits of well-designed learning environments is that it allows students to explore concepts from a variety of angles based upon their needs (Darling-Hammond et al., 2014). Albert Gore, Jr. supported the potential for computers to improve education in the 1970s and almost fifteen years later introduced the National Education Software Act (Gore, 2008). This piece of legislation provided funding for research and the development of educational software (Gore, 2008). In essence, Gore predicted the impact computers, coupled with the Internet, would have on education when the Internet was in its infancy back in 1984. The Internet, coupled with advanced software development technologies, has the opportunity to transform how information is delivered to K–12 students, as research shows that more interactivity creates a positive learning environment (“The Research Basis, ” 2008).

Educational websites are packed with a lot of information from a variety of sources that a student usually cannot find in a single classroom textbook; moreover, they provide a student a wealth of information that they can easily filter through to investigate various topics inside their area of study. Many authors and publishing companies of classroom textbooks are now providing websites to accompany their textbooks. Such websites may include sample chapter test or quizzes, PowerPoint slides containing some of the major points discussed in each chapter, and even an exploratory section that allows students to read further or investigate different topics the teacher may have presented in class. This is beneficial because students can have unlimited access to these materials and not have to retain paper copies. These kinds of websites allow the student to learn and discover above and beyond what is in the textbook. It allows students to gain additional classroom assistance that will increase their knowledge in the subject area taught by the teacher and will help them prepare for tests throughout the school year.

Over the past two decades, there has been an overwhelming emphasis on learning sciences, especially in the area of computer-supported collaborative learning (CSCL) environments. The idea behind CSCL is to encourage students to work together in small groups to solve problems or share knowledge on different topics. CSCL allow students from the same school or different schools to cooperate while learning new concepts and following a set curriculum through a web-based application. Thus, web-based applications can allow several students to come together to work on a class project from their local computer instead of traveling to the library or another student's home to assemble to work on the project. It is also an effective solution to incorporating technology into the classroom because it is more cost-efficient than other kinds of technologies and applications.

Web-based applications allow for visual and hearing-impaired students to join in on the fun because new technologies have been developed to support Section 508 Compliance standards and web browser screen readers (e.g., JAWS). Applications purchased with federal funds are required to be accessible and user-friendly to people with disabilities. Moreover, the web Consortium has also put into place Web Content Accessibility Guidelines (WCAG), which are substantive to standards in Section 508; however, the WCAG also contain guidelines that will help people who may have older computers or slower network connections. Many developers are following Section 508 standards when developing educational web applications.

2.4 Web-Based Tools and Technologies

With the popularity of the Internet, web applications are becoming more standard because of the ubiquity of web browsers. Web applications can be accessed from many portable devices such as smartphones, Netbooks, laptops, and PDAs as long as there is a network connection or from non-portable devices at home, office, or a local library. Staying connected to the web at all times has become a priority of this generation.

Computer software application companies are choosing to develop web applications over traditional Windows applications because it allows them to update and maintain the applications more easily. If software is built and sold on a disc, when a major update or defect arises, major issues and costs arise via the redistribution of the software to all client users. Potentially, thousands of users would need this new physical piece of software. With a web-based solution, one can update the web-server and the new application is available immediately to all users with access.

Several new technologies have also been developed to make web applications more dynamic by providing interaction to the user immediately without having to post back. Some of these technologies are JavaScript, Ajax, Flash, and Silverlight. These new technologies allow the teacher to provide a fully interactive user experience to the user.

2.5 Users and Users Experiences with CSCL Systems

A preliminary study conducted at Auburn University showed that Computer-Supported Collaborative Learning (CSCL) systems developed using a model-view-controller pager are adequate for developing learning environments targeted towards the K–12 audience. Collaboration among students within a learning environment has proven to have some benefits to students (Knutas, Ikonen, Ripamonti, Maggiorini, & Porras, 2014). Such benefits identified in other research have shown positive effects on learning (Ngai, Lam, & Poon, 2011). Medina et al. (2013) demonstrated a promising research area by identifying a core set of user design guidelines for CSCL systems. The researchers surveyed 33 teachers from different backgrounds and levels of education using a forum-based prototype system. Each survey participant expressed his or her experience using the system. Based upon the results, 70% of those surveyed felt that a forum type virtual tool will be good for K–12 education and expressed confidence in using the proposed tool if it were available. These tools allow students to collaborate in solving a problem or researching a topic (Medina et al., 2013).

Nielsen (2010b) investigate usability, presenting some key points that researchers must take into consideration when designing web-based systems for children (see Table 2.1). When designing web-based applications for K–12 students, designers need to use a different set of usability guidelines to build a successful environment that will be conducive to learning in the classroom (Nielsen, 2010a).

Table 2.1

Similarities and Differences between Adults and Children

	CHILDREN	ADULTS
GOAL IN VISITING WEBSITES	Entertainment	Getting things done Communication/community
FIRST REACTIONS	Quick to judge site (and to leave if no good)	Quick to judge site (and to leave if no good)
WILLINGNESS TO WAIT	Want instant gratification	Limited patience
FOLLOWING UI CONVENTIONS	Preferred	Preferred
USER CONTROL	Preferred	Preferred
EXPLORATORY BEHAVIOR	Like to try many options Mine-sweeping the screen	Stick to main path
MULTIPLE/REDUNDANT NAVIGATION	Very confusing	Slightly confusing
BACK BUTTON	Not used (young kids) Relied on (older kids)	Relied on
READING	Not at all (youngest kids) Tentative (young kids) Scanning (older kids)	Eye Scanning
READABILITY LEVEL	Each user's grade level	8th and 10th for broad consumer audiences
REAL-LIFE METAPHORS E.G., SPATIAL NAVIGATION	Very helpful for pre-readers	Often distracting or too clunky for online UI

	CHILDREN	ADULTS
FONT SIZE	14 point (young kids) 12 point (older kids)	10 point (up to 14 point for seniors)
PHYSICAL LIMITATIONS	Slow typists Poor mouse control	None (unless disabled)
SCROLLING	Avoid (young kids) Some (older kids)	Some
ANIMATION AND SOUND	Liked	Usually disliked
ADVERTISING AND PROMOTIONS	Can't distinguish from real content	Ads avoided (banner blindness); promos viewed skeptically
DISCLOSING PRIVATE INFO	Usually aware of issues: hesitant to enter info	Often recklessly willing to give out personal info
AGE-TARGETED DESIGN	Crucial, with very fine-grained distinctions between age groups	Unimportant for most sites (except to accommodate seniors)
SEARCH	Bigger reliance on bookmarks than search, but older kids do search	Main entry point to the Web (e.g. Google)

This proposed research developed a set of usability guidelines for developing CSCL environments for K–12 students. The system that resulted from this research requires the safety and privacy of K–12 students while working in the system. For the success of the system, the students' opinions will weigh heavily on the adoption and the usability of the system. When the students evaluated the system, they provided their opinion and suggestions to improve chances for the future adoption and improved usability of the system. In the preliminary study, one of the areas that received the most adverse feedback was concerning the design of the prototype that was built and evaluated by the study participants. The goal for the final system was to address the design issues as well as focus on children-centered usability guidelines.

To verify the usability of the final system, the researcher used an approach similar to that which evaluated the preliminary application. However, a survey based upon Norman's seven usability principals resulted in information shown as part of the contributions of this dissertation.

2.6 The Distinction of My Research

This research concentrated on reviewing computer collaboration literature and use the knowledge to design a model for an adaptable and collaborative learning system to support informal learning amongst K–12 students. Informal learning focuses on learning outside of the traditional classroom whereby students spend their own time learning about a particular subject (Boustedt et al., 2011; Galanis et al., 2014). Through reviewing CSCL literature, the researcher found valuable insights on how computer supported collaborative learning enhanced collaboration within an informal learning environment. The conclusions from the review of literature was used to implement an informal learning system as well as produce a usability guide to support the design of K–12 learning environments. To gather data that will have more impact instead of being a one-time study, this work was a longitudinal series of studies to provide more detailed insight into the model and applications of this model (i.e., the standard is a one-time study of two to five individuals). More distinctive is that most computer collaborative learning studies are conducted over short periods of time, but this study was conducted over a longer period of time to provide a wider view of the user experience of the final system.

Furthermore, no work has been found that uses usability guidelines to produce a system specifically for K–12 teachers and students concentrating on both collaboration and adaptability. The few available studies deal with specific problems but do not focus on human studies. This study will also conduct preliminary usability studies before the system is adopted for use. The survey will focus on K–12 students as the main stakeholders with K–12 teachers and usability experts as secondary stakeholders. The feedback from users will help to validate the system and offer insight into the viability of an informal learning environment for sharing and exposing students to information that is normally not taught within rural low-income areas. Since data will be from real students, educators, and usability experts, their responses and the results drawn from their responses will be treated as accurate information and of high significance.

Each participant was given an entrance questionnaire to determine his or her background before completing the main survey; this will ensure the accuracy of the data collected. The data was used as a foundation for the evaluation and future redesign of this work to support the sharing and exposure of knowledge among K–12 educators and students in the near future.

As this research also included security, the researcher adopted a model that defuses individuals and the government's concerns regarding protecting minors from the dangers envisioned in the World Wide Web. This system captured minimal information as possible on students in order to accurately provide them learning resources that target their interest. Many social networking sites have gone against this norm and encouraged the sharing of minor's information online. This research secured minors' information and addressed any security concerns through a holistic approach. The model proposed in Chapter 6 comprises a comprehensive security method, with parental and teacher supervision as a new security feature besides the adoption of an isolation method accessible only through tunneling (i.e., isolating the system from the web as a virtual online center with limited but enough online services). Consequently, the researcher ensures the security of minors by having both a parent and teacher validate that they are indeed a minor and they are approved to use the system for required purposes after the initial sign-up.

CHAPTER 3: METHOD

This chapter introduces the research problem, the hypotheses, and the research questions of the study. It also elaborates on the characteristics of the empirical/experimental research that are general to all studies, which will be discussed in detail in the subsequent chapters. It will introduce the research problems, the arising queries and the hypotheses addressed by the user study as well as describe the characteristics of the analytic and empirical research context. In this project, study questions and hypotheses was investigated as the further benefits of an informal learning environment for supporting learning among novice users. A complete evaluation of a comprehensive study between a web-based informal learning environments, traditional methods discussed and is part of this research report.

For K–12 students and educators to use virtual space effectively, users should be empowered to use the software system to suit their needs. In the current educational environment, K–12 educators have no time, desire, or motivation to learn new tools let alone develop lessons and refine information to share with students in various subject areas. Thus, there is a need to develop a tool to serve the needs of students who want to expand their educational opportunities. An easy way to provide a secure and trustworthy learning environment utilizing the Internet as the deployment framework is by adopting an existing tool, tailor it and evaluate it with users (e.g., Microsoft SharePoint). However, these tools are aimed at serving professionals with significant experience in the systems and software packages. Many of these applications have not been evaluated regarding the user experience in terms of novices.

Hence, this study focused on students, who, in most instances, were novice computer users. This research project focused on K–12 students and educators to understand the need for an informal learning environment to expand the knowledge presented during traditional educational methods, build user-designed guidelines and a tool that addresses those needs, and evaluate the effectiveness of such a tool in comparison with existing tools or traditional methods.

Many empirical studies support K–12 student and teachers collaborating and sharing knowledge using web-based applications (Cain, 2010; Dillenbourg, 1999). However, such studies have focused on higher education distance learning using content managers like Moodle, Canvas, Blackboard, and WebCT to support collaboration and delivery of materials. Although several tools support collaboration, most do not incorporate a learning environment as well. This study primarily focused on providing a secure learning environment for K–12 students that would increase their flexibility and allow them to personalize their learning experience beyond what is offered in the traditional classroom setting. Such an environment also had the capability to keep private information. This project provided an easy-to-use environment that supports confidentiality like that provided by Blackboard. The final application was easy to use, user friendly and robust enough for students and educators who may self-report as computer illiterate, but are able to intuitively utilize the environment with little to no formal training.

The researcher worked to provide empirical data and results to support the further development of a trusted application for K–12 learning online or in a virtual space. Based upon the literature review, the researcher found little evidence of a unique system currently secure enough and specifically tailored towards K–12 students learning and sharing resources within an environment conducive towards learning. Thus, to motivate K–12 students and educators to collaborate and share resources, educators need an easy-to-use and more secure tool that can be trusted by students and their parents. This system limited access to any private information that may be stored with the content database while maintaining data integrity and confidentiality.

The model for this new environment must follow security guidelines on how to protect K–12 students in the learning environment from unsolicited contracts while advancing collaboration and the sharing of knowledge and resources. In addition, the system takes into consideration the preferences of the students and avoids the pitfalls that haunt online college educational systems, like poor user interfaces. Therefore, a key area of the final work was usability. In order to make sure our application was adopted by this mobile app-driven generation, our final work included building a children's user experience guide able to support the development of the system. This final work produced better organization of material and more support for users to who want to personalize their learning experience.

This research investigated the question: "can a web-based application be successfully developed with modules that are designed to be responsive and supportive in the informal learning process?" The goal is not to merely redesign an existing application designed to support higher education collaborative groups, but to drive the design process based upon student input and proven usability techniques. If not addressed properly, how much do user perceptions about security and current satisfaction with traditional learning methods affect the adoption of the tool? The researcher conducted surveys to query stakeholders on the usability and learnability of this type of application. The potential stakeholder, K–12 students, educators, and usability and design experts responded as to whether this concept was a noble idea of collaboration and provide a wider range of instructional programs options for students in a web-based learning environment. After the system was fully developed with the security features and a custom K–12 friendly user interface, what will be the users' response to its usability? How will the usability of this web-based adaptive and collaborative environment affect the user's motivation in exploring a wide range of instructional courses? The answer to these questions provided the framework for implementing a successful environment for supporting students (8th – 11th grades) to take advantage of courses being offered in an informal learning environment.

3.1 Research Approach

The four main goals of the study were to (a) enhance technical skills of novice users, (b) encourage users to adopt the use of technology for informal learning instead of traditional teaching methods, (c) provide a flexibility and personalized learning experience to users, and (d) produce a user design guide that strictly focus on the development of learning environments for the K–12 audience. Additionally, this study has two main targets: (a) support low-income or budget-strapped K–12 school districts and (b) encourage the learning of a new environment for collaboration and informal learning. The study focused on the usability of the application and compare its usefulness with that of a previous application via data from K–12 students' populations in the initial stages of this study.

Our study was conducted face to face and consisted of three separate parts. First, participants completed a questionnaire that gathered basic demographic information as well as their prior experience with informal learning or self-directed learning. Next, participants were allowed time to interact with the ChemiNet application. This application was built during the preliminary study of designing web-based applications to support informal learning. Next, participants could interact with the new web-based application built as part of this study. Finally, the researcher ended the session with a post-questionnaire that asked questions about both systems.

The experimental participants answered a broad array of questions through questionnaires in order to gather data in support of the research study. The survey required a user to self-identify himself or herself as a novice or as having advanced computer skills for the purpose of assessing the impact of the application on subjects.

To gather more data on the usability and effectiveness of the environment, experimental participants performed a series of task to test the usability of the environment. While performing the tasks, participants answered questions about the steps immediately to provide more precise feedback on certain parts of the application. At the end of the list of tasks, users were required to take a final survey where they could provide feedback on their overall experience of the system.

The researcher divided the project into four phases, as outlined in Figure 3.1 with detailed explanation in the subsequent sections.

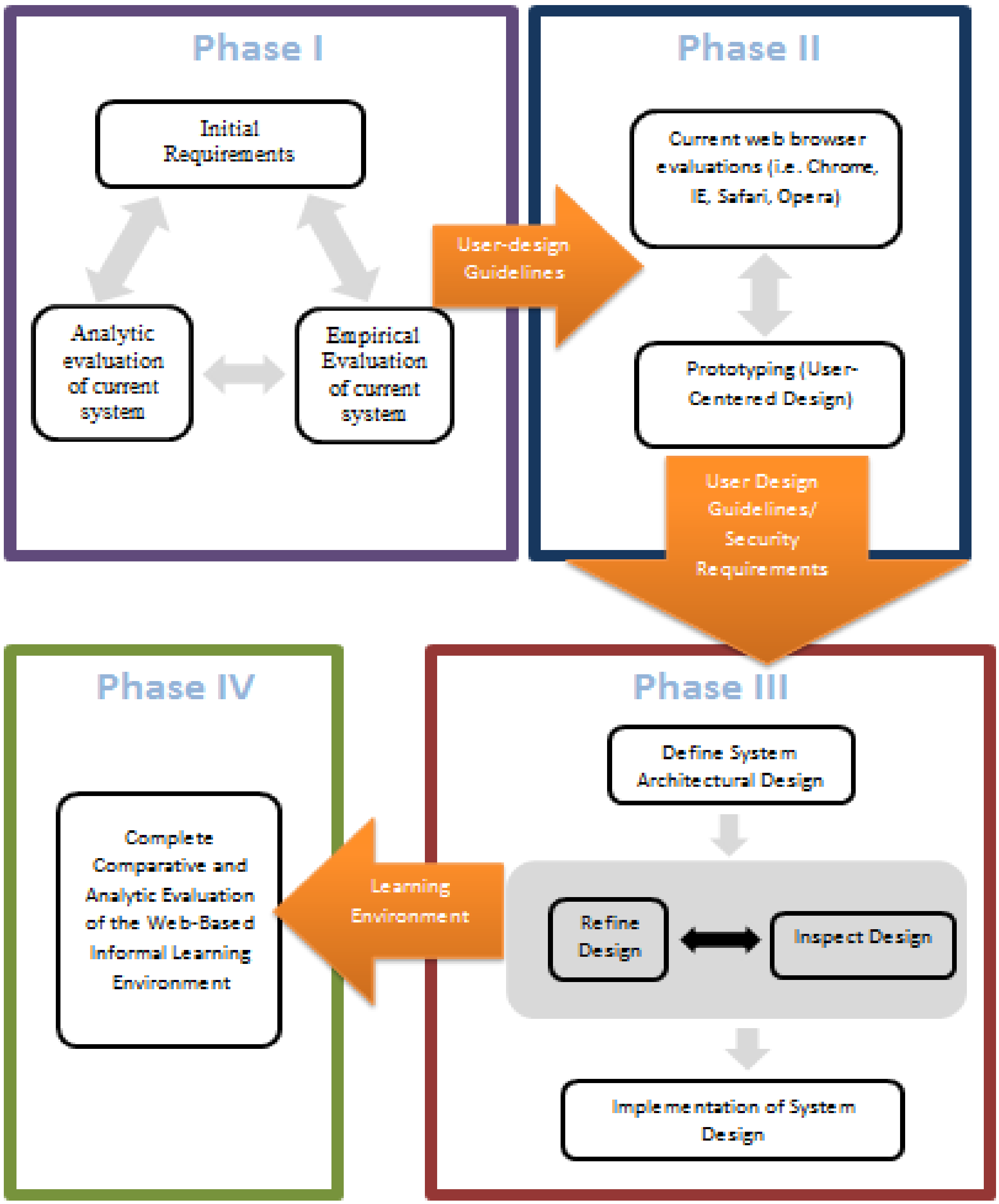


Figure 3.1: The Informal Web-Based Learning Environment Development system cycle, design refined, interface prototypes, created with the initial prototypes iterated.

3.1.1 Phase I: Requirements

The researcher gathered phase I requirements based upon a pre-questionnaire survey of the ChemiNet application as well as the post-questionnaire. Subsequently, the researcher conducted a thorough usability and security inspection and analysis on ChemiNet as well as on the existing web-based learning tools/software using a scenario-based approach. Finally, the usability and security of two best-rated tools were evaluated empirically based on the issues identified by the inspections and scenarios-based analysis. The results led to the requirements for an iterative design and development work for the desirable, secure, and usable web-based learning environment needed for phase II.

3.1.2 Phase II: Evaluation and Prototype

A comprehensive evaluation—both analytical and empirical—gauged the success of the interface designs for the K–12 students in comparison with the existing system. The process included a comparative usability inspection of the initial ChemiNet system with a detailed study using qualitative and quantitative outcome measures. The researcher also conducted field study to see how students are interacting within their current environment.

3.1.3 Phase III: Design and Implementation

The researcher developed the architectural system design and implementation of the web-based learning environment using the user design guidelines and system security requirements for K–12 learning environments. The design process includes the development of paper prototypes of one or more system designs. Once the design meets all the security and user design guidelines from Phase I and II, more concrete designs were built moving from low-fidelity prototyping to high-fidelity representation of the new design. Once a solid architecture design is identified, the middle portion of Phase III moves into a more iterative design inspection and refinement process. Once the design has been inspected and refined based upon the established usability, user-design guidelines and security, the final design was implemented.

3.1.4 Phase IV: Analysis

In the first three phases of the study, the researcher planned to investigate security and usability hurdles in order to design and implement a viable web-based learning environment. The final stage of the study focuses on the evaluation of the final product. A comparative as well as an analytic and empirical evaluation was conducted. The stages are tailored to produce results for the research questions outlined in this proposal.

3.2 Research Questions

In the first phase of the study, the researcher planned to investigate the security and usability hurdles facing web-based learning environments on the Internet as well as explore the suitability of user interfaces of existing tools used for learning content management. As technology evolves in this digital age, there is a need to capture K–12 students' interest by offering flexibility through sequential screening. Sequential screening allows a learner to access information on a mobile device such as a smartphone or tablet as well as a laptop/desktop computer. Having these access options for web-based learning environments opens a systems audience to more users.

The following overarching question guided my dissertation work: How can the design of age-appropriate learning-focused technologies be usable and secure for students within low income communities, and what are the implications of doing so? The research examined how students are affected by participating in informal courses within a web-based portal and by accessing the material of other students and teachers. In particular it examined three implications of this strategy in designing informal learning-focused technology:

- What factors keep student engaged with course material that is being shared;
- How accessing this information will affect them from a security/usability perspective; and
- How sharing course information affects their confidence that they can and are improving their knowledge in a particular subject area.

Specific Research Questions:

RQ1: With what aspects of informal learning would individuals in low-income areas like to see offered that they don't have access to now and what type of considerations need to be made when providing these types of courses? What type of learning activities would they like to see?

RQ2: What types of factors (usability and security) need to be engaged in order to provide a usable and secure environment for the K–12 audience? RQ2a: Are there any key usability issues that face K–12 students when trying to learn within an informal learning environment (Jacob Neilson Guidelines)? RQ2b: Are there any key security concerns for students accessing course information in a web-based environment?

RQ3: In what ways does providing informal learning courses affect how students feel about the quality of education they are receiving? RQ3a: Based on the course they participated in, do they feel an increase understanding in the subject area and/or felt it was valuable information?

RQ4: Do students feel that they can and are improving their knowledge in various subjects offered by completing courses within the informal learning environment?

3.2.1 Technical Skills

Current web-based environments supporting K–12 informal learning on the Internet rely heavily on advanced technology skills and super user privileges. Users must have the ability to download programs or add-ons before they can utilize the system fully, causing the user to only access the site on a personal computer on which they may have administrative rights. The original tool chosen for the web-based learning is brittle from a usability point of view, because it requires user-installed client programs, which are not friendly for novice or beginners with fewer tech skills. In response to the limitations for the first choice tool, the ChemiNet application was designed to provide a flexible and easy means for all users to access course material using the Web without having to install client programs. However, the ChemiNet prototype course/assessment style tool has limitations on usability due to its appearance, and its lack of secure login is vulnerable to online security threats. In this study, researcher implemented a new tool: a secure web-based system to address the security and trust issues as well as redesigned interfaces in accordance to the needs of the users (K–12 students) to improve usability and increase the motivation among users by simplifying means of accessing course material without needing any advanced technology skills.

3.3 Hypotheses

For K–12 students to collaborate successfully in a learning environment, they must share information. The implemented web-based learning environment provided a framework for students to express their ideas realistically in real time and through various types of media. The implemented web-based learning environment structure incorporated features that are great for sharing quality information with ease via templates. To validate the implemented web-based learning environment’s easy to use features, the researcher conducted a series of studies with participatory design, scenario-based design, qualitative evaluation and usability analysis through user surveys (i.e., surveys on how easy it is to post and comment on a practice relying on the availed features).

With the use of example templates to create successful courses, users had a simple task of sharing information by simply clicking icons on the screen (i.e., successful stories would be easier to share among students by uploading them from various electronic storage spaces by mouse selection). The environment used standard templates for sharing course material. The resulting presentations were standard among all students. The following empirical study focused on the effectiveness of user interface and the usability of the forms—implemented web-based learning environment templates—in comparison with the traditional methods of offering informal courses among the selected research groups.

This research is based on the three research questions listed below that leverage the hypotheses tested at the end of the study. The empirical study compares the traditional method and the virtual community of practice methods. At the end of the study, the usability, trust, and analysis of the user interface by experts and other test group participants was used to test the hypotheses of the research. The data collected during the experiment and through qualitative observations and surveys is presented in consecutive tables and other statistical methods (Chapter 7).

A. Hypotheses I: User Satisfaction/Learning

The implemented learning environment is a web-based tool that allows for sequential screening and is easier to learn and use than other learning management tools that require the use of installed client-based (Windows-based) programs.

HA_1: There will be a significant difference between the usability and learnability of the control and experimental environments in terms of user ratings of overall satisfaction ease of use, and motivation.

HA_2: There will be a significant user satisfaction with the implemented web-based learning environment versus traditional methods of collaboration and informal learning options for K–12 students in low income communities.

HA_3: There will be a significant increase in the morale among K–12 students' satisfaction with ease of use of the implemented web-based learning environment versus traditional collaboration tools, e.g., BB-based tool.

B. Hypotheses III: Usability

HB_1: Information created and shared in the implemented web-based learning environment tool will have a more cohesive design with a more attractive and updated look with features that appear in modern websites.

- HB_2: There will be a significant difference between the preliminary web-based environment and the implemented web-based learning environment interface based on the usability experts' evaluations.

HB_3: There will be a significant improvement in experts' ratings on visual quality and organization of information on the implemented web-based learning environment tool versus traditional methods.

3.4 Experimental Procedures and Tasks

This project used both qualitative and quantitative data to present results. The analysis relied heavily on qualitative data to investigate how the implemented web-based learning environment can be enhanced to encourage informal learning by K–12 students (i.e., encouraging K–12 students enrolling in informal learning courses). The researcher collected data from participants through surveys using online tools in response to the usability of the proposed implemented web-based learning environment.

In spring 2010, the researcher conducted a usability study on 21 students for feedback on the viability of implemented web-based learning environment. All the participants were drawn from the local Upward Bound. When surveyed whether ease of use and security were a major concern in their decision to use an online tool for collaboration, 60 percent of the respondents said they preferred a secure system that easy to use. To continue the study, researcher proposed a new system for web-based learning and extended our surveys to more diverse groups with different demographics and expertise. For the sake of data collection, the researcher chose participants from the following sources:

- Usability experts in the Computer Science and Software engineering department,
- Willing participants from the Auburn University community in any capacity, and
- Members of a local Upward Bound program.

In the initial survey, the participants were categorized by gender. There were more female than men participants due to the gender disparity in the K–12 student population. The survey results revealed that 42.1 percent of the participants had online experience and had taken an online course previously; thus, they were not categorized as novice computer users. The researcher conducted the study by e-mailing the participants a link to the tool and asking them to perform a few tasks without providing a detailed user guide. Later, the participants were asked to fill out a survey concerning their experience with the tool. The conducted survey was based on a predetermined standardized user interface survey questionnaire with few modifications of added questions vital for participants' classification purposes.

The survey yielded the following general results:

- Forty-two percent of the students said they would prefer an online system for learning over traditional teaching methods;
- Eighty-five percent of the subjects said the prototype needs an improvement on its appearance because the system did not allow for customization nor did it fit their character;
- Forty-two percent of the students felt that they and their peers could learn better in a virtual learning environment; and
- Thirty-six percent of the students said that they would enroll in an online course if they had the option.

The researcher used the implemented web-based learning environment to survey the K–12 students on the learning environment ideology before making conclusions on the prospects and effectiveness of the implemented web-based learning environment system as a suitable tool for K–12 students to use as a means to take enriched course not offered using the traditional method due to limited funding.

The researcher conducted the survey based on the findings of the pilot study as well as the literature review and results collected through a questionnaire. The researcher analyzed the results gathered from the questionnaires via quantitative and qualitative statistical methods to determine that the implemented web-based learning environment is feasible and beneficial and that it improved collaboration and access to enrichment courses through sharing and re-use of course material in K–12 education.

3.5 The Experiment

Traditionally, students within low-income communities with limited funding for enrichment courses do not have the means to enroll in courses from private vendors. With the emergence of online environments, many students have resorted to wikis and other websites to explore different areas of interest without knowing if the information they are viewing is valid or accurate.

However, most of these communities have students with a variety of different technological skills and varied access to technology based upon the location and resources available, such as afterschool access to computer labs and a local library. Due to the variety of learning environments and management systems available, there is debate on which environment or system will be more suitable for these students to easily access course information. Most existing educational environments were created to satisfy the need for content management to cater to structured learning situations. None of these tools has been tailored to cater to novice users or designed with a loose structure that allows novice users to learn at their own pace and access the material on a variety of devices despite their limited technological skills. Though there are many ways of sharing knowledge between K–12 students and teachers, many of them have not fully ascribed to the available technological tools to share and re-use course material because of the time required to acquire the necessary client-based, Windows-installed programs. To acquire the necessary programs and to become familiar with them takes time and effort, a hindering factor due to the students' already rigorous course load. Therefore, encouraging the use of the technology to access course material and collaborate with other students needs an environment that is easy to use, user friendly, and easy to learn and does not require any installation of client-based programs or advanced technological skills.

In this experiment, the researcher designed a new user interface for a web-based learning environment in virtual space aimed at fostering learning through an educational enrichment course. The researcher considered three styles of login wireframes (i.e., design dashboards) to be rated and evaluated by user interface design experts and K–12 students. The basic design was the current interface: the version compared for improvement was the next design version of this system with added features.

Our methodology was to gather demographics from user groups before they began this experiment to find their level of computer efficacy, general educational background, and technophobia levels. The experimental portion of the work began with a list of tasks that provided design experts an opportunity to access the usability, usefulness, and aesthetics of design. At the conclusion of the experiment, the users completed a post-questionnaire.

3.5.1 Setup of Experiment

In order to collect data for our study, the researcher designed, configured, and implemented a web-based learning tool for participants to perform various tasks to provide feedback on its usability. The tool was developed, tested and evaluated in the Auburn University CSSE HCI lab. The details of the first two applications are found in Chapter 4 and Chapter 5.

To perform the experimental tasks, participants must have access to the Internet through a web browser. The specifications of the machines were not considered, but the latest browsers were recommended. The system could also be accessed through hand-held devices, iPad, iPod, Blackberries, web-accessible cell phones, and Android. The experiment had pre-selected usability experts because they provide reliable feedback from a designer's point of view as the first group of participants. The group is considered highly technical and with a minimum of four years of professional usability testing experience (e.g., HCI graduate students).

The second group was composed of K–12 teachers who are certified to teach in their respective states in the United States of America. The teacher group were further categorized into the computer novices and the advanced computer skills groups through a pre-survey questionnaire.

The third group of participants included the K–12 students enrolled in a local Upward Bound program. The members of this group were considered novice users per a pre-questionnaire for the sake this research. Normally, K–12 students with a local Upward Bound Program take enrichments classes through face-to-face instruction. This is aimed at further improving their enrichment course offerings by providing a platform that is available throughout their schools where they can take a course anytime they feel like. The researcher utilized hand-held devices, phones, iPods, Androids, and Blackberries that are prevalent in most rural areas for Internet connectivity. The researcher took into account the fact that there is limited access to fast Internet connection in most rural areas, but, with available satellite communication, a majority of the areas have fast Internet access through hand-held devices.

3.5.2 Experimental Procedure

The research experiment is web based. The subjects who agreed to participate were sent a link through e-mail or invited on site with the details of the study in order for them to complete it at their own convenience. Before taking part in the study, participants were provided with an IRB form to inform them of their rights. The IRB also notes that their participation was purely voluntary and that they could withdraw from the study at any time without any giving any reason. The experiment process had four sections: (a) signing consent form, (b) pre-questionnaire, (c) web-based learning Subscription/Enrollment through URL, and (d) post-questionnaire (See Figure 3.2).

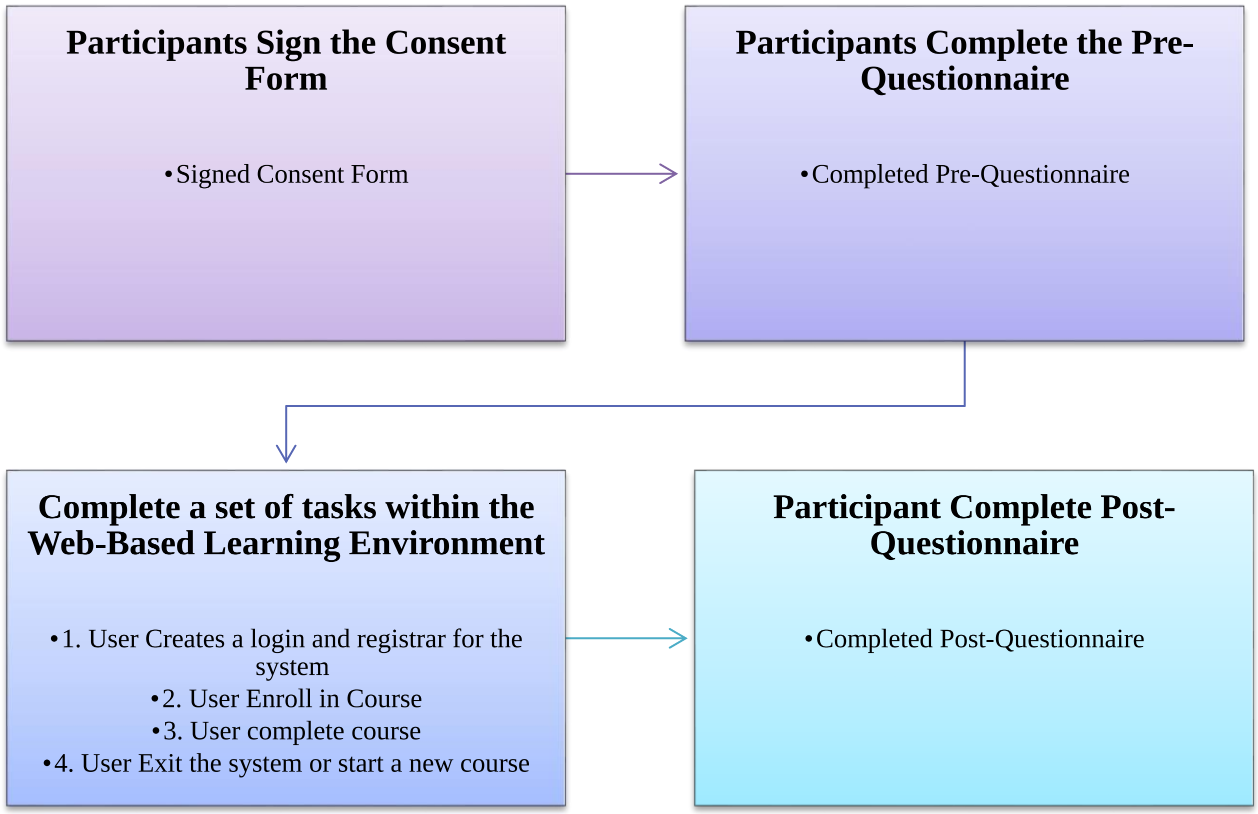


Figure: 3.2: Experimental procedures sequence of event chart

CHAPTER 4: PHASE I: CHEMINET DESIGN AND EVALUATION

With the popularity of the Internet rising, there are many new types of web-based applications being introduced daily. They are typically social networking sites such as Facebook and online gaming and simulations sites such as Second-Life and Multiplayer virtual worlds. Students spend countless hours immersed into the computer. Technology has the power to transform the level of education provided by secondary schools through an interactive environment that can be tailored to each student. Web-based learning environments provide a low cost and effective way to deliver and engage students in a particular subject. It does this by allowing multiple students to enroll in a course at once. There is no enrollment limit based upon the number of teachers available as in a traditional classroom setting. In order to evaluate the usability of an online learning environment and gather user design requirements for these types of environments, an application was designed. The ChemiNet application was designed as a prototype of a module-based framework to support e-learning. The application contains a course that can be used to reinforce basic chemistry by providing a dynamic web-based environment for students to explore concepts that may or may not have already been introduced by traditional instructional methods.

Accessing educational content from the web is very common by educators and students. Educators may use the content they access to help enrich classroom lessons. Students gather content from the Internet in order to support them with homework or course projects. The goal of this project is to provide an informal learning environment where students can enroll and advance their knowledge in a particular subject area. The motivation for this project came from a high school chemistry teacher who outlined the experiences of teaching chemistry in a traditional classroom setting. Chemistry textbooks are loaded with tons of information, however, if you open a high school or basic college chemistry course textbook, the first thing that is normally seen behind the front cover is the periodic table. It is one of the most fundamental pieces of knowledge a chemistry student understands before indulging deeper in the "composition, structure, and [chemical] properties of substances" [Webster Definition]. The periodic table of elements dates back to the nineteenth century, even though additional elements have been discovered over the years. Therefore, the project objective was to create a web-based application that is engaging, interactive and provide an excellent user experience to support STEM education (e.g. chemistry).

4.1 Framework

The demands from today's application users from a usability standpoint are steadily increasing. Therefore, to meet these demands, the .NET framework is an excellent framework for building dynamic and modern web applications. It is a powerful application framework that is widely used in Windows applications and is geared toward the development of interactive web-based applications. It provides a host of features sets that are able to be accessed from the .NET framework environment. Today's users are expecting web applications to function like installed Windows applications, not loading the page each time data has to change, but providing an instant connection to the database that refreshing data without causing a post back to the server (Chappell, 2007). The .NET framework provides access to many new technologies. These technologies include: ASP.NET AJAX, Language-Integrated Query (LINQ), Windows Communication Foundation, Windows Workflow Foundation, Windows Presentation

Foundation, and Windows CardSpace. With these tools, developers are able to make more powerful and dynamic applications for their user.

One of the most popular and widely used technologies of the .NET framework is the ASP.NET AJAX library, which makes it a "dominant approach for designing" (Chappell, 2007) web-based applications. This library provides several controls that increase the usability of a page. As an example, a developer can use an "UpdatePanel" control if they only need to refresh a certain section of the page instead of refreshing the whole page. Several of these controls can be placed on one page allowing the page to only update once section at a time depending on the user interactions. These powerful controls allow developers to provide a better-quality application and an enhanced user experience.

The .NET Framework is the latest mainstream web application framework which is very popular among industry development teams and is used to facilitate rapid application development. Therefore, it is a dominant platform for developing and running next generation Windows applications. The .NET framework was constructed in order to promote advanced web-application development by fulfilling these objectives:

- A consistent object-oriented programming environment
- A code-execution environment that minimizes software deployment and versioning conflicts
- A code-execution environment that promotes safe execution of code
- A code-execution environment that eliminates the performance problems of scripted or interpreted environments.
- A developer's experience that is consistent across widely varying types of applications, such as Windows-based applications and Web-based applications.

- An environment where all communication is built industry standards to ensure that code based on the .NET Framework can be integrated with any other code (“Overview of the .NET Framework,” 2005).

4.1.2 .Net Web Applications

.NET web applications are most commonly created using Visual Studio. Visual Studio has been around for several years and there are currently many versions of this software on the market. The latest version is Visual Studio 2010. The Visual Studio allows developers to create a .NET project. Once this project is created developers can add forms, user controls, JavaScript files, Cascading Style Sheets (CSS) files and C# class files. If your development efforts contain more than one project, a new solution would need to be created in order to support this effort. A solution can consist of two or more projects.

Web forms are asp.net forms that consist of an ASPX page and an ASPX.CS page. The ASPX file is the web form page where all the asp.net server-side controls are placed and HTML code was written. This is also where you address layout issues and other user’s interface design problems. Any web browser can open ASPX files. The next file that is generated is an ASPX.CS web form file. This file is associated with the ASPX file. It contains all the event handlers’ methods for server-side controls. Commonly, this file is written using the C# programming language.

4.1.3 ASP.NET Controls

The .NET framework has several standard built-in controls that a developer can choose from when developing a web-based application. These controls can be used as a standalone control placed within the application or can be combined into a user control, which is a grouping of several controls. The .NET framework also allows the developer to create custom controls.

There are several types of custom controls. One is called a user control. User controls are similar to web-pages in which they can "include code to manipulate its contents like a page can, including performing tasks such as data binding" ("MSDN Library," 2011). The other three types of custom controls are called inherited controls, owner-drawn controls, and extender providers. The first two are more powerful and complex types of custom controls that can give your application more flexibility, while the later allows you to add components to other control within your ASPX web form.

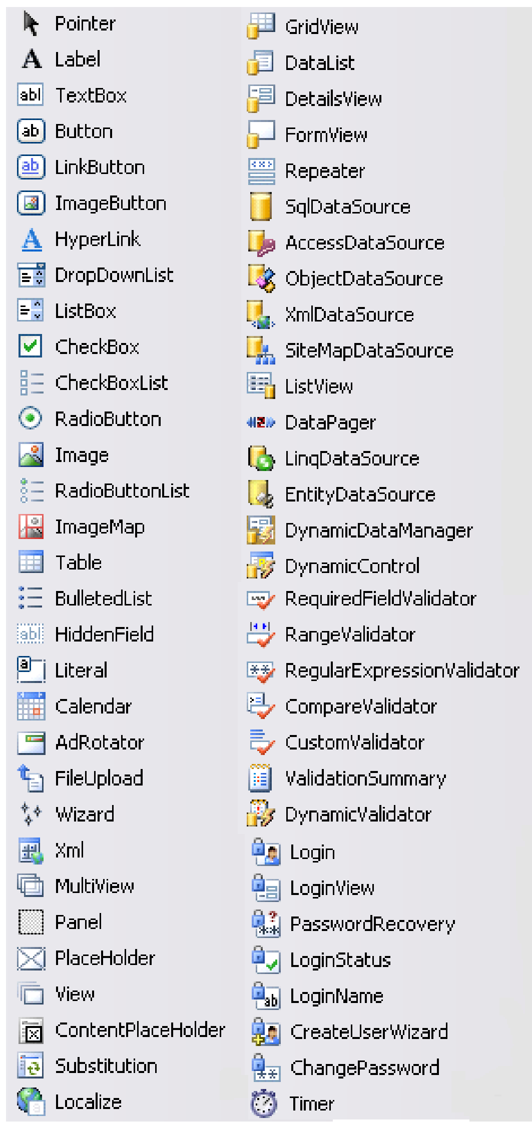


Figure 4.1: ASP.NET Out-of-the Box Controls

4.1.4 C# Programming Language

The C# programming language is the main programming language of the Microsoft .NET framework. All information pertaining to the C# programming language can be found within the Microsoft Developers Network (MSDN) website. The C# language is a powerful modern programming language and is rivaled by Java. It combines the “high productivity of Rapid Application Development (RAD) languages and the raw power of C++” (“MSDN Library,” 2011). The C# programming language and .NET framework can be utilized to build several types of applications such as games, dynamic web and windows applications, and compilers. C# is an object-oriented programming language where all code resides within classes. The current version of C# is 5.0. See Table 4.1 for a list of features added in each version (“MSDN Library,” 2011).

Table 4.1

Summary of C# Versions

FEATURES ADDED	C# 2.0	C# 3.0	C# 4.0	C# 5.0
	• Generics • Partial types • Anonymous methods • Iterators • Nullable types • Private setters (properties) • Method group conversions (delegates)	• Implicitly typed local variables • Object and collection initializers • Auto-Implemented properties • Anonymous types • Extension methods • Query expressions • Lambda expressions • Expression trees	• Dynamic binding • Named and optional arguments • Generic co- and contravariance • Embedded interop types ("NoPIA")	• Asynchronous methods • Caller info attributes

4.2 ChemiNet Functional Requirements

The ChemiNet application has five primary requirements that need to be fulfilled in order to achieve the project objectives. The five requirements are as follows:

- FR1: The application must be web-based
- FR2: The application must be engaging, which means that the interface must be attractive and exciting for our target user group.
- FR3: The application must be interactive, meaning that the user is able to interact and the application provides feedback based upon the user interaction.
- FR4: The application must provide a good overall user experience, meaning that the user should be able to easy use and learn the application.
- FR5: The application must support a lessons taught in traditional chemistry classroom, meaning the application should function as web-based learning environment that enables students to learn basic information concerning chemistry.

The first requirement is that the system shall be hosted on a web-based platform. To fulfill this requirement, the system was implemented in the following web-enabling implementation technologies: Active Server Pages (ASP).NET, Hypertext Markup Language (HTML), JavaScript, and C#.

The second requirement is that the application shall be engaging. To fulfill this requirement, the system was created using an ASP.NET Master Page, which allows the application to have a consistent layout for the pages within my application. This master page defined the “look and feel and standard behavior” (“MSDN Library,” 2011) for the ChemiNet application.

The third requirement specifies that the application shall be interactive. The goal of the application was to allow the user to communicate with the computer through specified inputs and the computer responds by providing some type of output. Dynamic websites enhance the online learning experience compared to static websites. To fulfill this requirement, JavaScript, as well as, C# server-side code was used to provide click and mouseover functionality using the following methods: onClick and mouseOver. These methods allowed for an interactive user experience.

The fourth requirement states that the application shall provide a good overall user experience. To increase the user experience of the application, a significant amount of time was spent designing the user interfaces based on heuristic evaluations in order to support a flexible and cohesive design. In addition, before the application was released, a testing phase occurred to verify the requirements and validate the system functionality.

The fifth and final requirement states that the application shall support chemistry. To fulfill this requirement, the application was built to support chemistry by providing a learning environment which allows users to explore concepts and facts concerning the periodic table of elements. As stated above, a concrete understanding of this table provides chemistry students with knowledge that they can build upon in subsequent chemistry courses and other studies in the science and mathematics field.

Once the requirements for the application were identified, the system was implemented using an iterative approach with the design approach as the next significant step in the process.

4.3 Design

Software design is a key component of the development life cycle when designing web-based applications. In the ChemiNet project, Evolutionary prototyping (EP) was employed. Our main goal was to build a robust and flexible prototype in a structured manner and constantly refine it. This process allows for continuous refinement of the system and allows us to refine parts of the application that require change. Functionalities were integrated on an interim basis until the final system is delivered. The initial prototype was developed based on the functional requirements captured and from thereon changes were made based upon feedback. Each prototype is built using the following software design process: Requirements, Design, Implementation, and Testing.

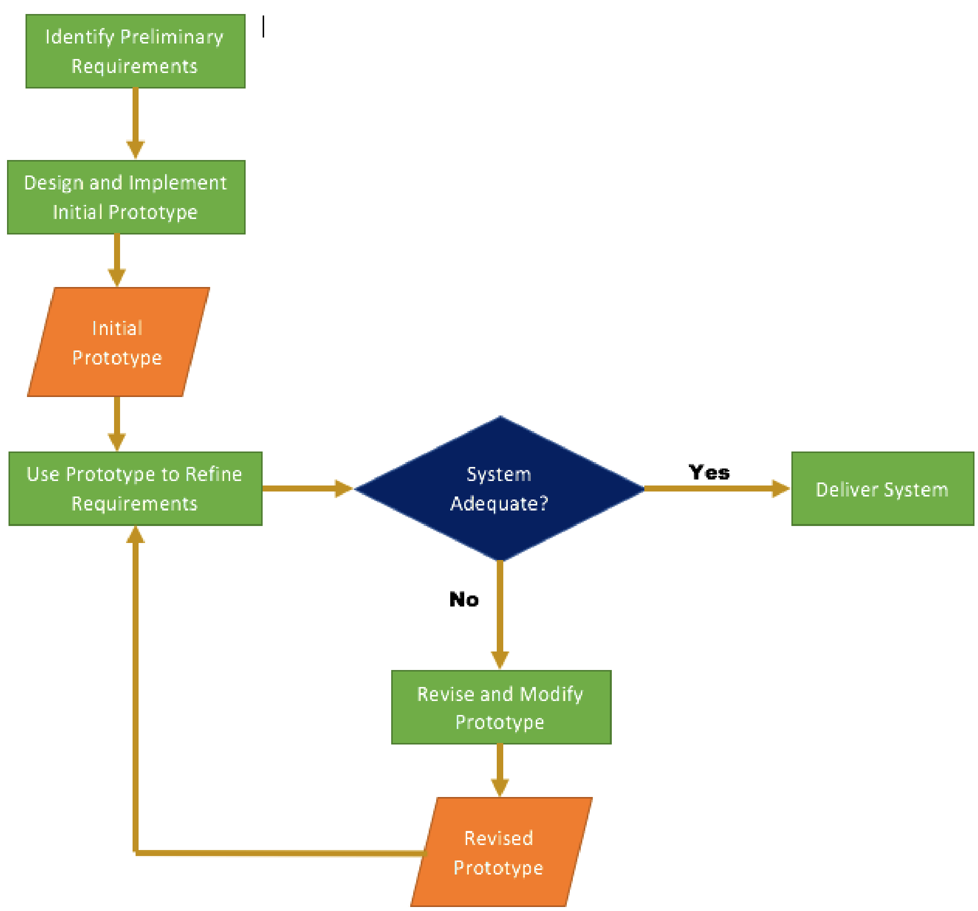


Figure 4.2: Evolutionary Prototyping Process

Several design artifacts were created using the Unified Modeling Language (UML) for many parts of the ChemiNet application. The first type of diagram that was created is the use case diagram. This diagram depicts the core actions a user can perform within the ChemiNet application. From the use case diagram shown in Figure 4.3, you can see each system function that the student user was able to perform in that user role.

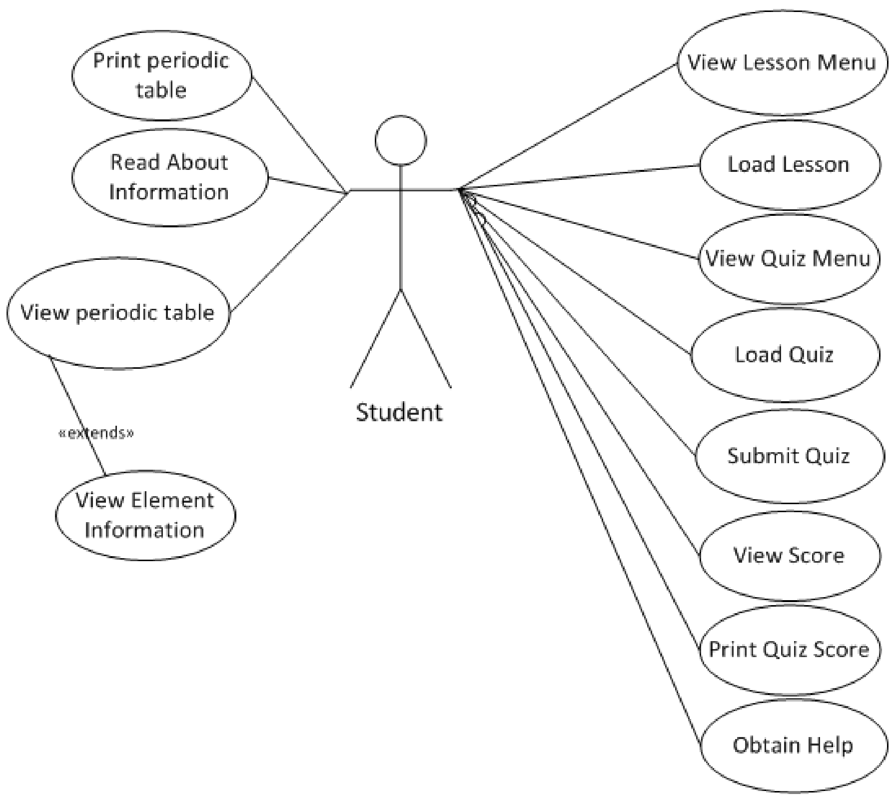


Figure 4. 3: ChemiNet Use Case Diagram

Once the system functions were outlined, the next aspect of the system that needed to be documented was how the system responds to task initiate by the student user. To illustrate the interaction between the system and the user, several system sequence diagrams were created. These sequence diagrams show the optimal response output based on input by a student user.

See Figures 4.4, 4.5 and 4.6 for the sequence diagrams for interaction with the lesson module, periodic table module and quiz module, respectively.

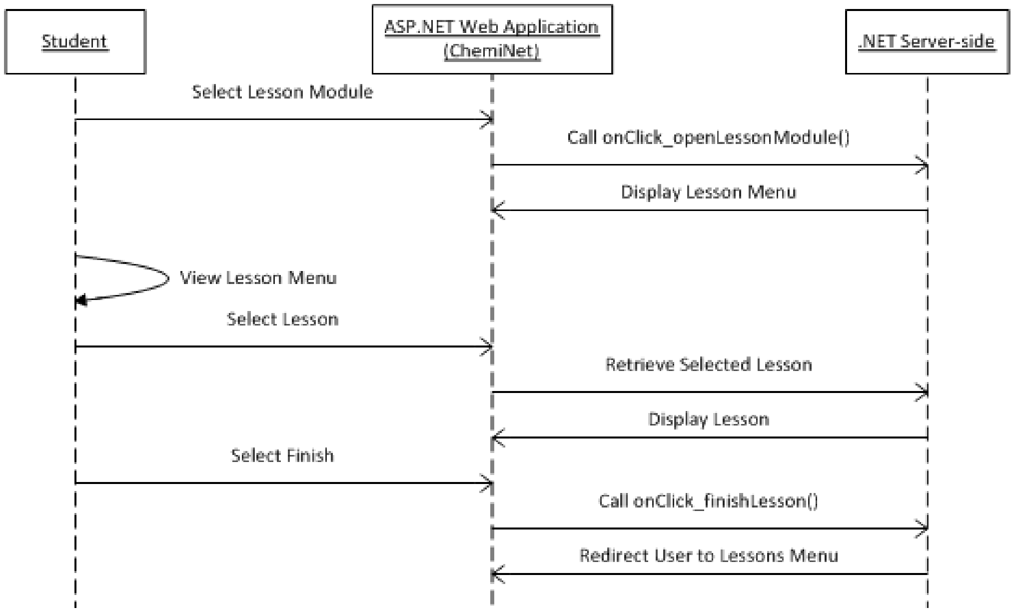


Figure 4.4: Lesson Module Sequence Diagram

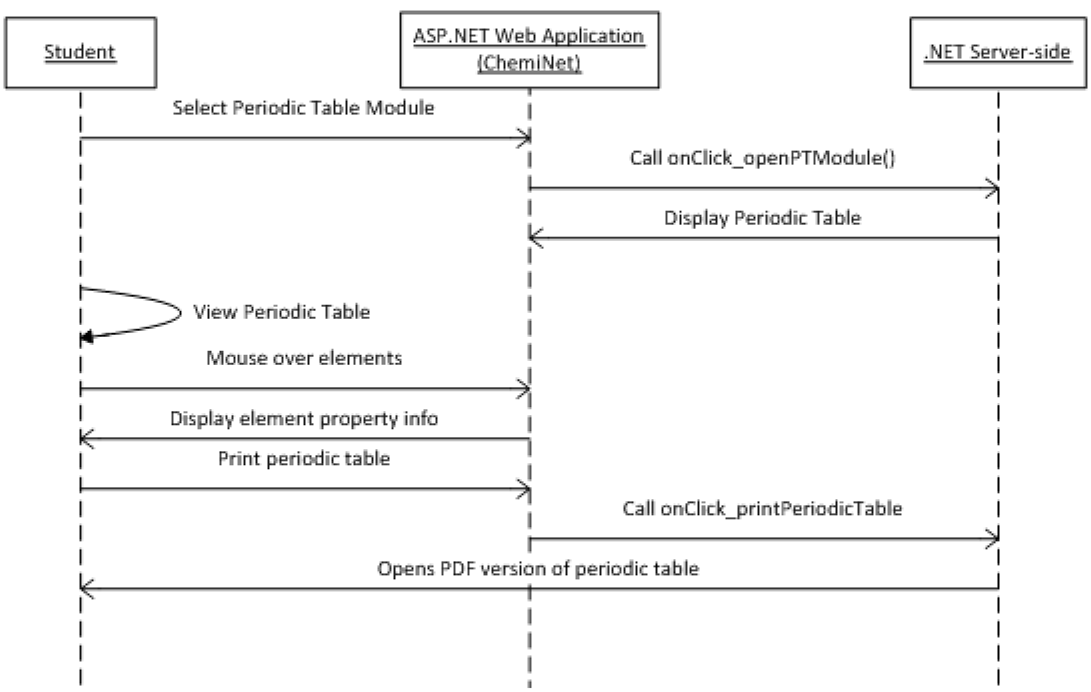


Figure 4.5: Periodic Table Module Sequence Diagram

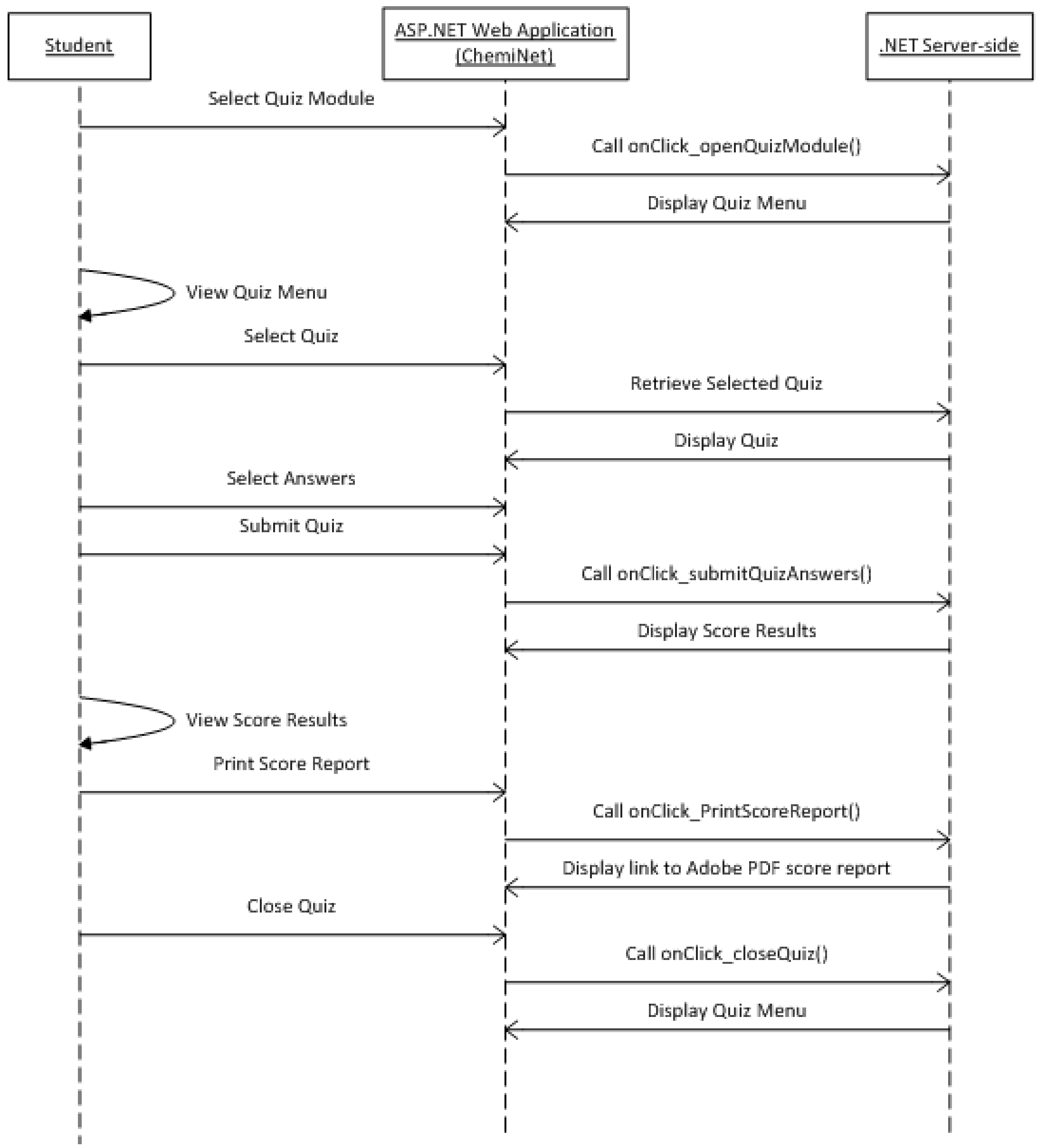


Figure 4.6: Quiz Module Sequence Diagram

4.4 Implementation

The implementation of the ChemiNet application was done using the Visual Studio 2008 interactive development environment (IDE) using the C# 3.0 programming language. As mention above in the .NET Framework section, this IDE provides a rich set of tools that allow you to create a dynamic web application, which were heavily used within the web forms that makeup the ChemiNet application.

4.5 ChemiNet

Using an agile software development process an interactive web-based learning environment was developed to provide an exceptional user experience to middle and high school chemistry students. This new web-based learning environment is called ChemiNet, shown in Figure 4.7. ChemiNet is designed to be a web-based learning environment where students can go through chemistry lessons as well as take quizzes based on a particular lesson. The application also features a fully interactive periodic table that allows students to go through and learn about each element. ChemiNet is a web-based application, which means it can be access from any computer with Internet access.

By choosing the .NET framework, a web platform, to implement ChemiNet makes it so versatile. Students can have access to ChemiNet from any computer with Internet access whether at school or at home. Because students can work collaboratively or independently, ChemiNet was designed to be easy to use with the student's understanding of the material being taught as the ultimate goal of the application.

The bright colors used throughout the ChemiNet application on the user interfaces takes into to consideration the audience for this application. Secondary education students tend to like things with bright colors and comical text. Also, the center of the home screen interface [see figure 4.7] contains a fun fact that changes when the screen refreshes or the page reloads. By offering such fun facts, students would be more motivated to visit the site so they can find out another fact about Chemistry to share with their classmates or family.

The goal of ChemiNet is to make the user interface easy to use, easy to learn and as less confusing as possible so that students using the application can have a pleasant learning experience. As shown in Figure 4.7, you can see some of the design choices that were made in order to satisfy ChemiNet goal.

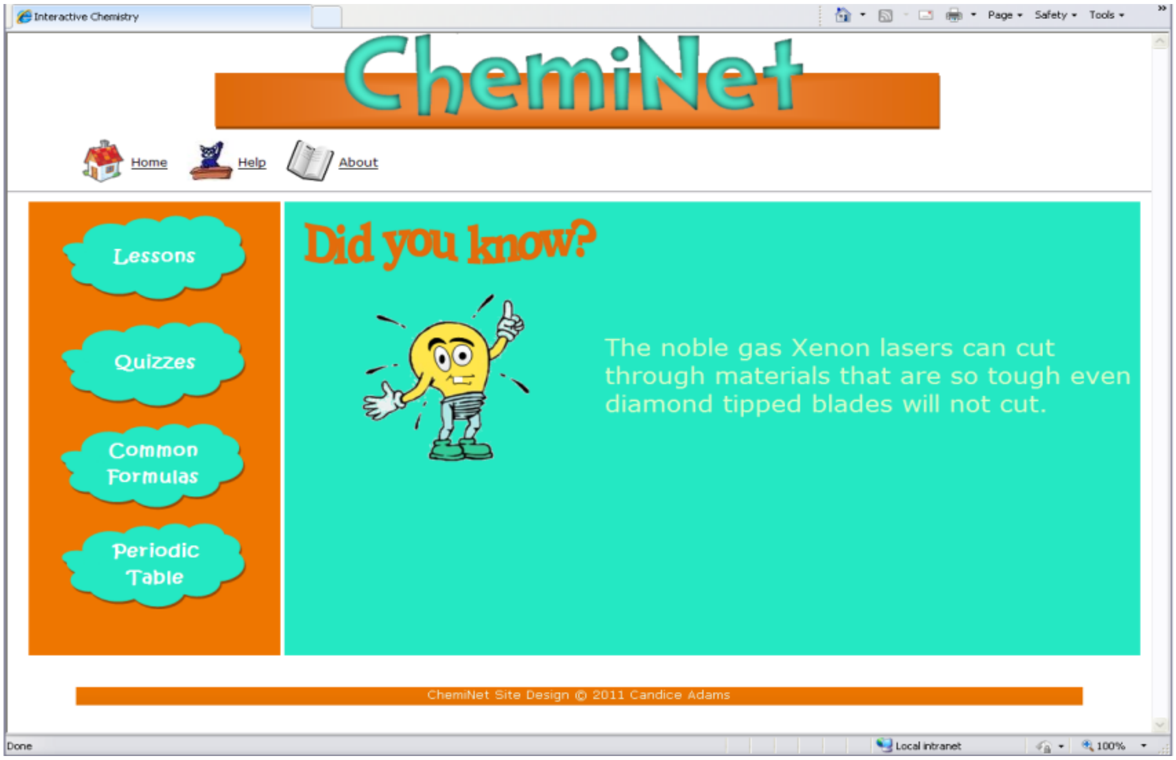


Figure 4.7: ChemiNet Home Screen

4.5.1 Home Splash Screen

With any web-based learning environment, it is necessary to pay close attention to the design of the user interface. From the home screen of the ChemiNet application, a user can navigate to any part of the application by using the non-intrusive navigation at the top and/or left side of the screen. One design decision that was made was to have modules, so a limited the number of options on the home screen. Based on this decision, larger buttons were chosen for these options. The large vertical menu buttons on the left side of the screen makes it easy for students to click without mistakenly clicking the wrong option (see Figure 4.8).

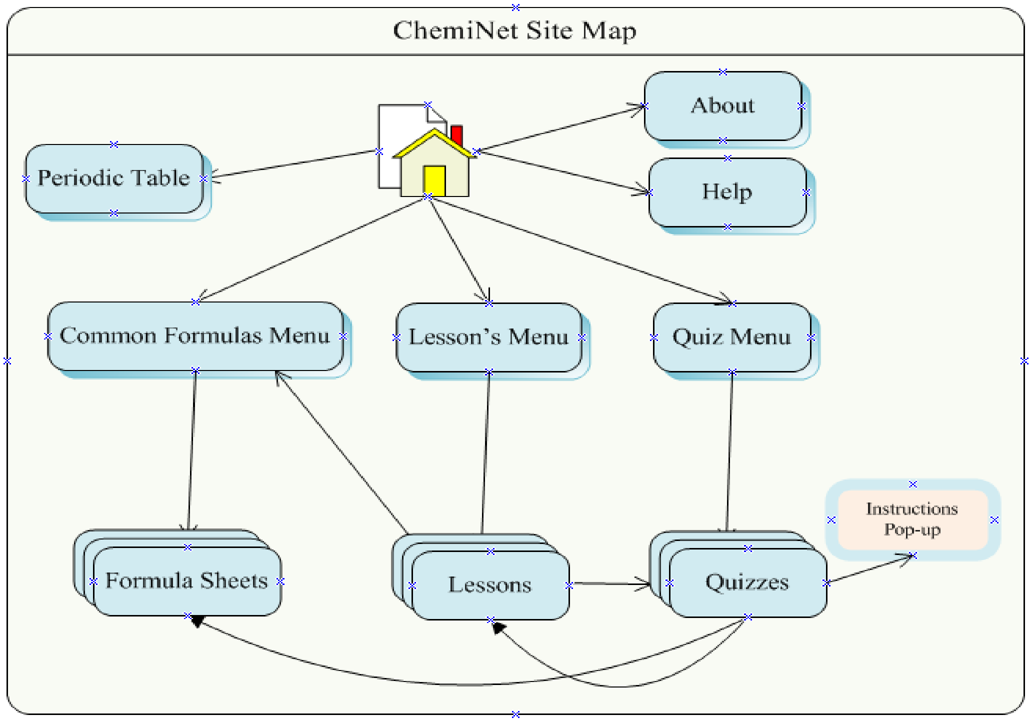


Figure 4.8: ChemiNet Site Map

The vertical menu section consists of four options. The options listed include Lessons, Quizzes, Common Formulas, and Periodic Table. Once the user moves the mouse over an option, the text turns to yellow to notify the user that this can be selected. This ensures the user is aware that this option is clickable. The horizontal menu includes more of the standard options a user will normally see if other web applications. The options listed include home, help, and about. The three options listed are always available because it enables the user to return to home or get help at any time while using the application. Therefore, each screen has a consistent screen layout in terms of the presence and location of the horizontal menu area. The vertical menu only shows on the home screen to continue with the non-instructive navigation scheme. The accessibility of the ChemiNet application is shown in Figure 4.7.

4.5.2 Module Screens

The ChemiNet application consisted of four modules. The material within the application is broken down this way that students will be able to quickly and easily find the section they are seeking within the application. For example, the quiz and lesson modules are separate because if a student finished a particular lesson, but did not have the time to take the quiz associate with that lesson, they can do that by directly accessing the quiz module and finding the quiz for that particular lesson. They do not need to go through the lesson again in order to access the quiz. So, in order to deliver an effective learning experience each aspect of the application was carefully positioned so little confusion and frustration will occur while using the application.

The lessons module is the first option in the vertical menu on the home screen. When you click on the lesson's module, it transfers you to the screen as shown below in figure 4.8. Due to the time constraints of this project, there is currently one chapter that contains three lessons. If more chapters with lessons are implemented, a dropdown list will appear and allow the user to choose which subject area or chapter they are seeking lessons for within the lesson's module. Noticed the vertical menu has been removed to allow additional room on the page. The goal was to make the page size as small as possible, so that if a student has a smaller screen, they will not have to scroll horizontally to see the full page. According to Jakob Nielsen, "avoiding horizontal scrolling" is an essential usability guideline (Nielsen, 2005).

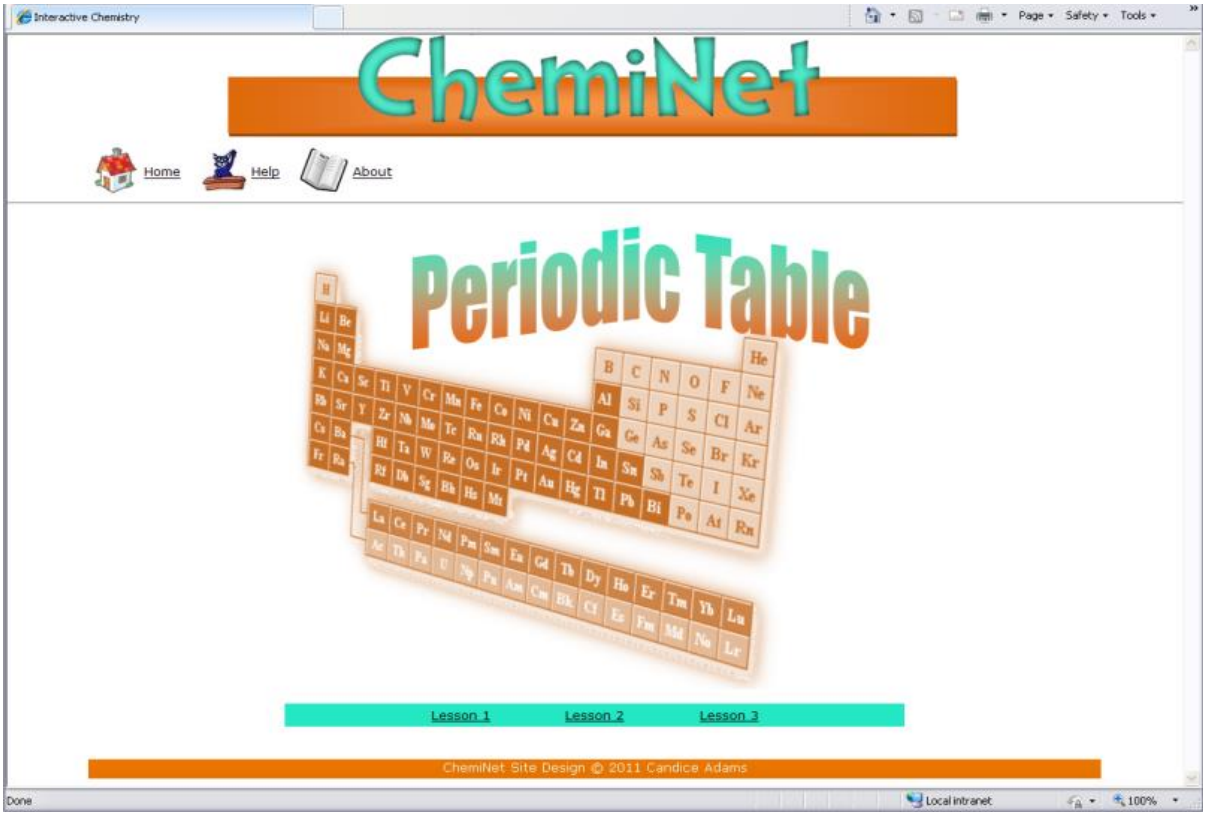


Figure 4.9: Lesson Module

The periodic table module contains a fully interactive periodic table, see Figure 4.10. The goal of this module is to allow student to have fun while quickly finding information on a particular element. By positioning the mouse over any element, a student can immediately see additional information pertaining to an element. This information is displayed in the element preview at the top left-hand side of the screen.

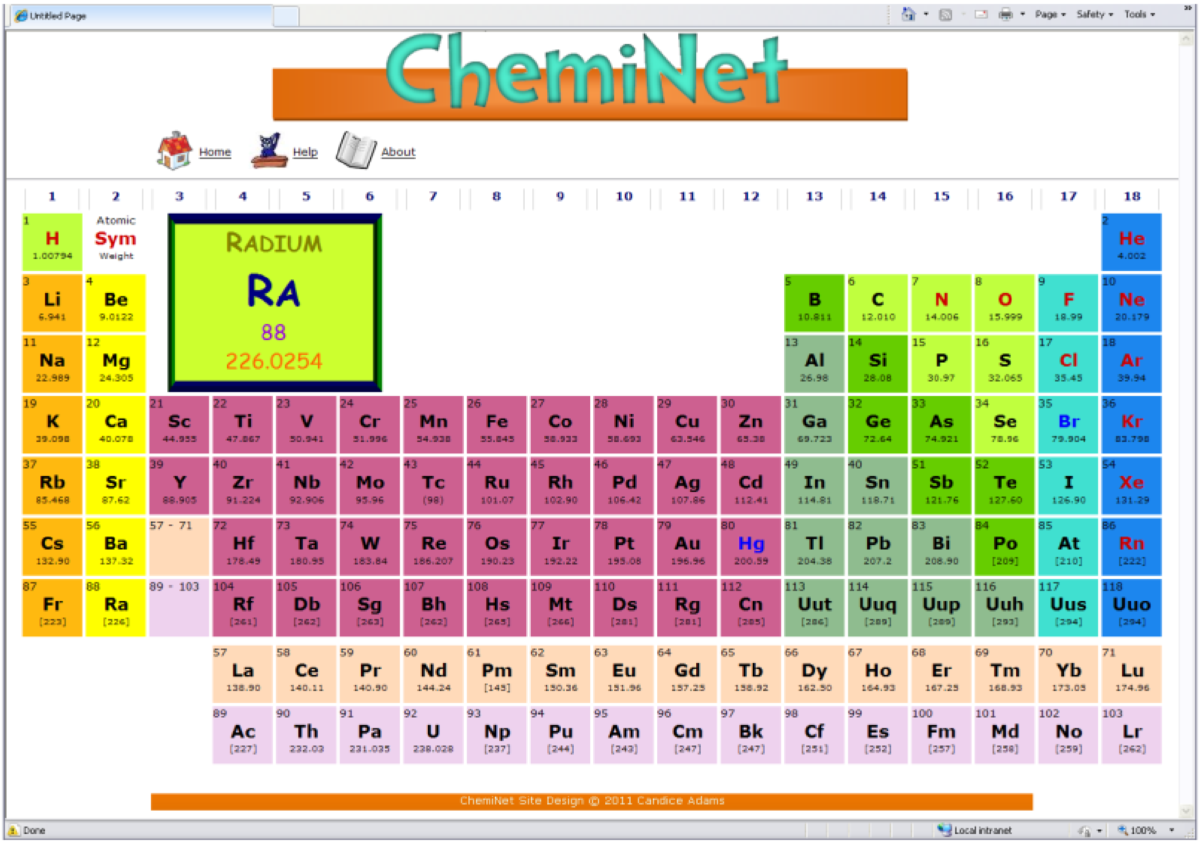


Figure 4.10: Periodic Table Module

4.6 Results and Analysis

When the ChemiNet project implementation was completed, an evaluation was conducted with high school students in 9th–12th grades. The evaluation was conducted over two days. During the first day, the researcher provided an overview of the ChemiNet application and asked all participants to complete two pre-questionnaire surveys. In the pre-questionnaires, the researcher asked questions such as how often the participants used a computer and where they normally have access to a computer (See Appendix A). For the evaluation of the ChemiNet application, there were a total of 21 users answered questions from pre-questionnaire 1 and a total of 19 users who answered questions from pre-questionnaire 2. Below is a breakdown of participants based upon grade level.

Table 4-2:

Participation Breakdown by Grade Level (2 Tables)

Pre-Questionnaire	
Grade Level	# of Participants
9^{th}	7
10^{th}	9
11^{th}	3
12^{th}	2

Post-Questionnaire	
Grade Level	# of Participants
9^{th}	9
10^{th}	6
11^{th}	2
12^{th}	2

Based on the survey results, 100% of the respondents who took pre-questionnaire 1 have access to a computer at one of the locations listed in Figure 4.11. Figure 4.11 also indicates that over 50% of the respondents have access to a computer at school or home.

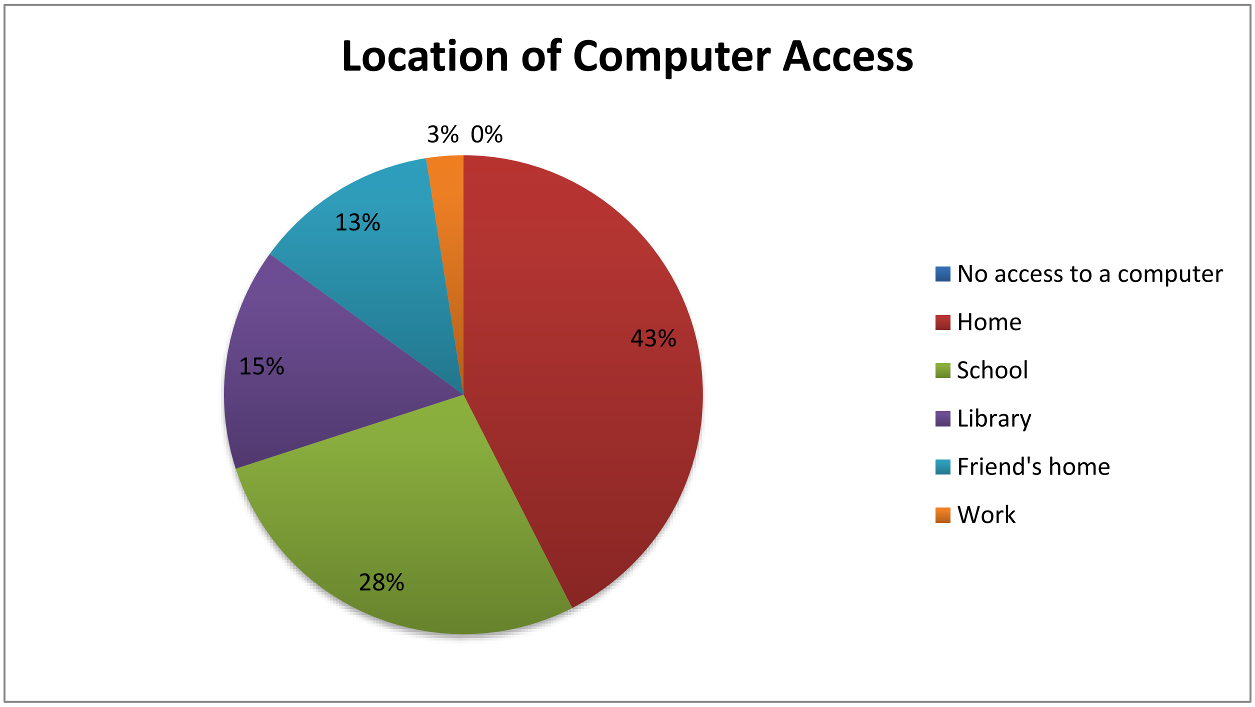


Figure 4.11: Location of Normal Computer Access

The researcher also discovered from pre-questionnaire 1 that over 90% of the students who took the survey were comfortable using a computer. The researcher defined comfortable as preferring to complete task on the computer, using the computer with limited stress, and feeling good about incorporating computers into your educational environment.

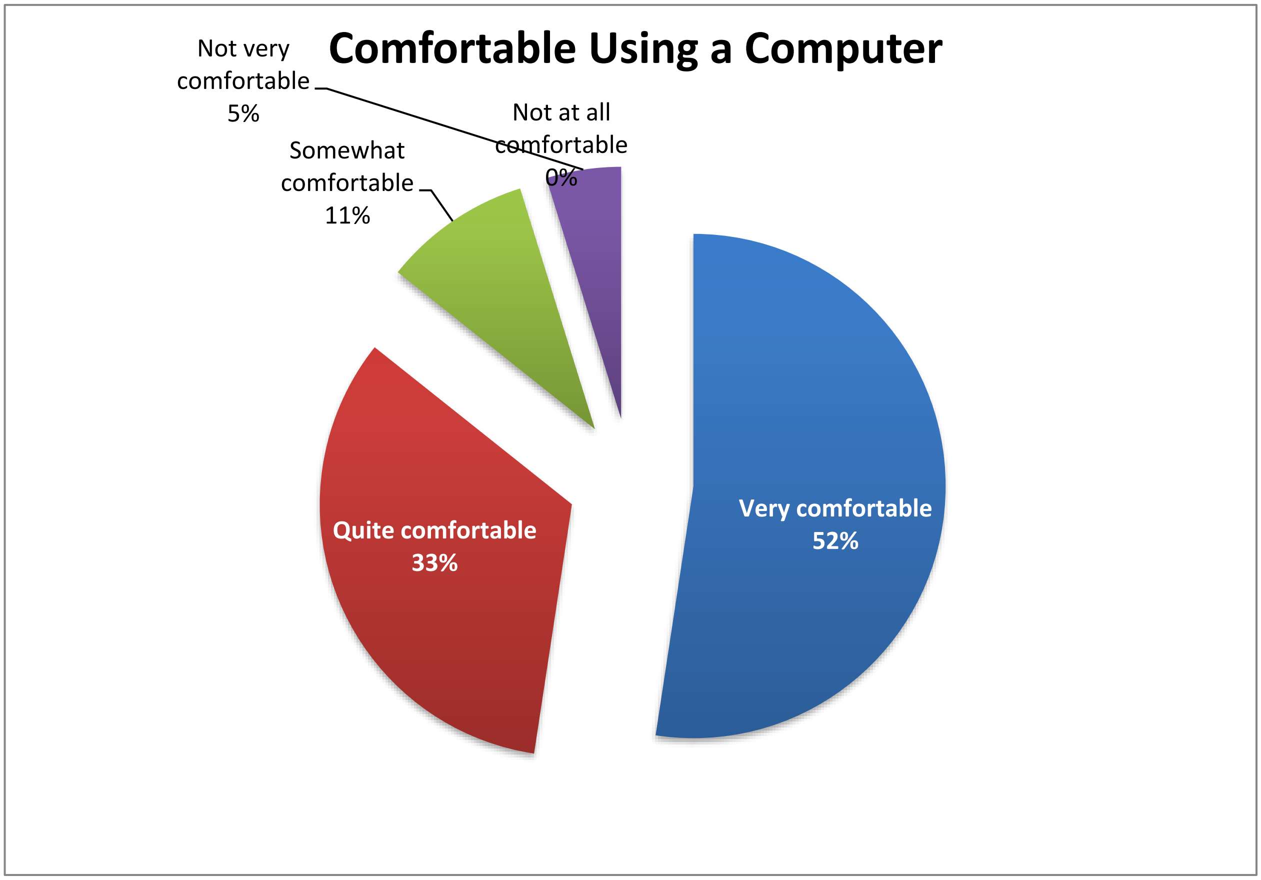


Figure 4.12: Comfortable Using a Computer

Pre-questionnaire 2 provided more insight on the participants' familiarity with virtual learning environments and chemistry in general. See Figure 4.13 for a review of the feedback provided.

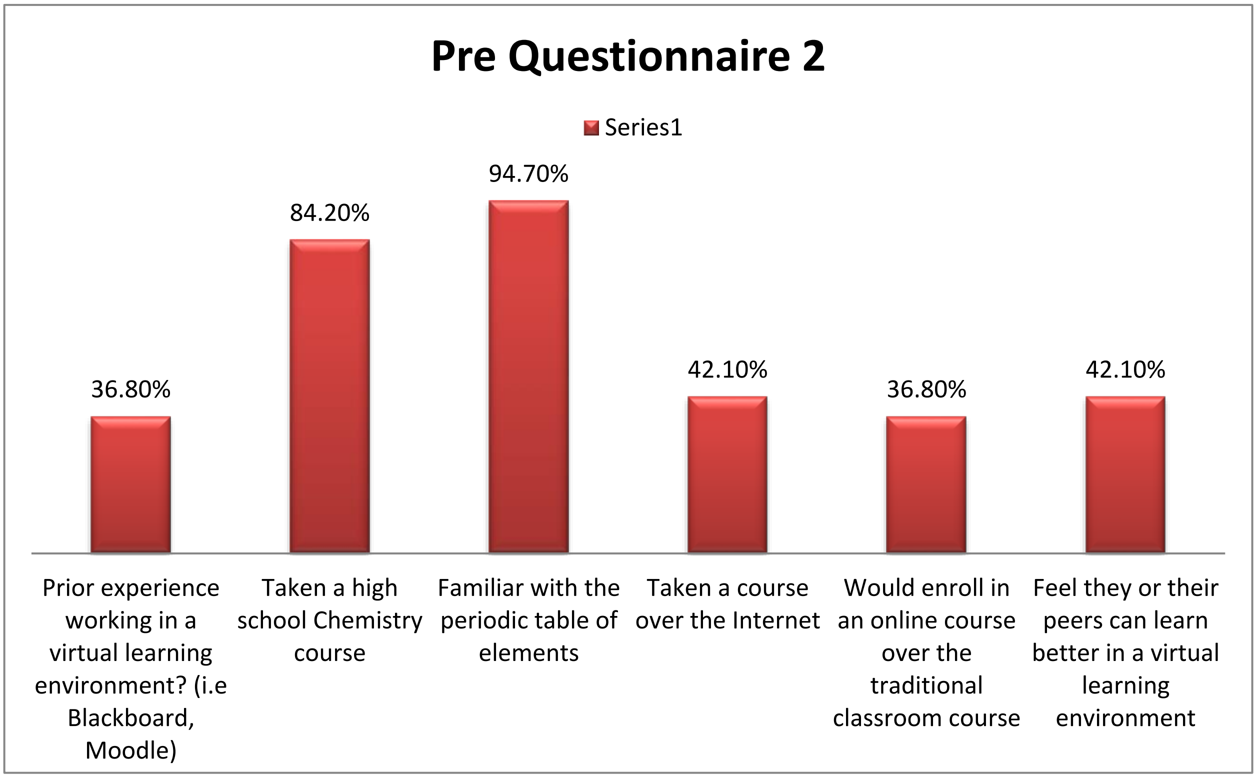


Figure 4.13: Pre-Questionnaire Online Learning Environment for Supporting Chemistry Lessons

By gathering this data during the pre-questionnaire session, the researcher was able to gain a lot of information about our users and use this feedback in the implementation of our application. Once the application was done and the evaluation was completed, the researcher scheduled another session with the group of high school participants. During this session, the researcher provided the participants an opportunity to play around in the web-based learning environment for about a half hour. To determine if the game promoted satisfaction among the users, the researcher conducted a post questionnaire. In the post questionnaire, the researcher asked questions such as ease of navigation and how well it reinforced basic chemistry knowledge. Based on the analysis of both post questionnaires, the researcher found that over half of the students who responded found that the application was easy to navigate through, fun and exciting. Majority also felt that students with limited computer experience is able to use the ChemiNet application with ease. See the analysis of our post-questionnaire results below in Figures 4.14 and 4.15.

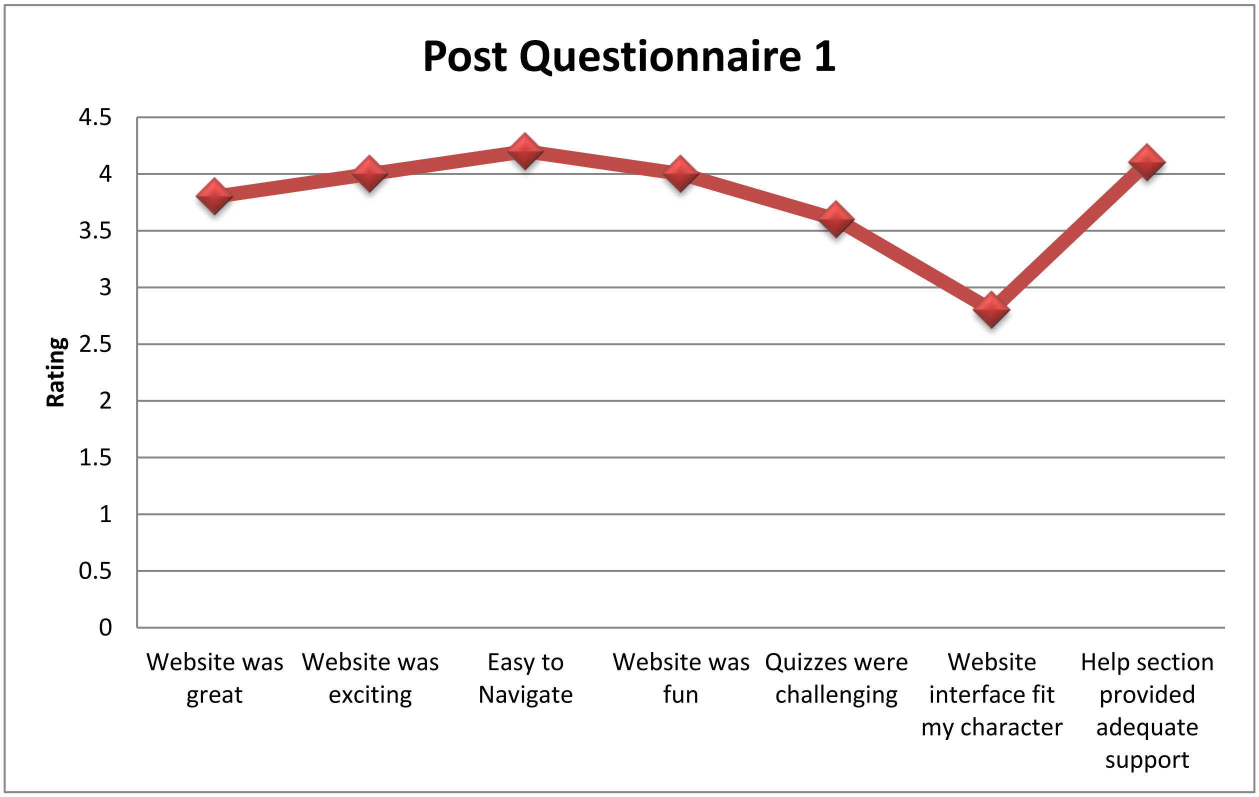


Figure 4.14: Post Questionnaire User Experience with Game (* 5pt scale)

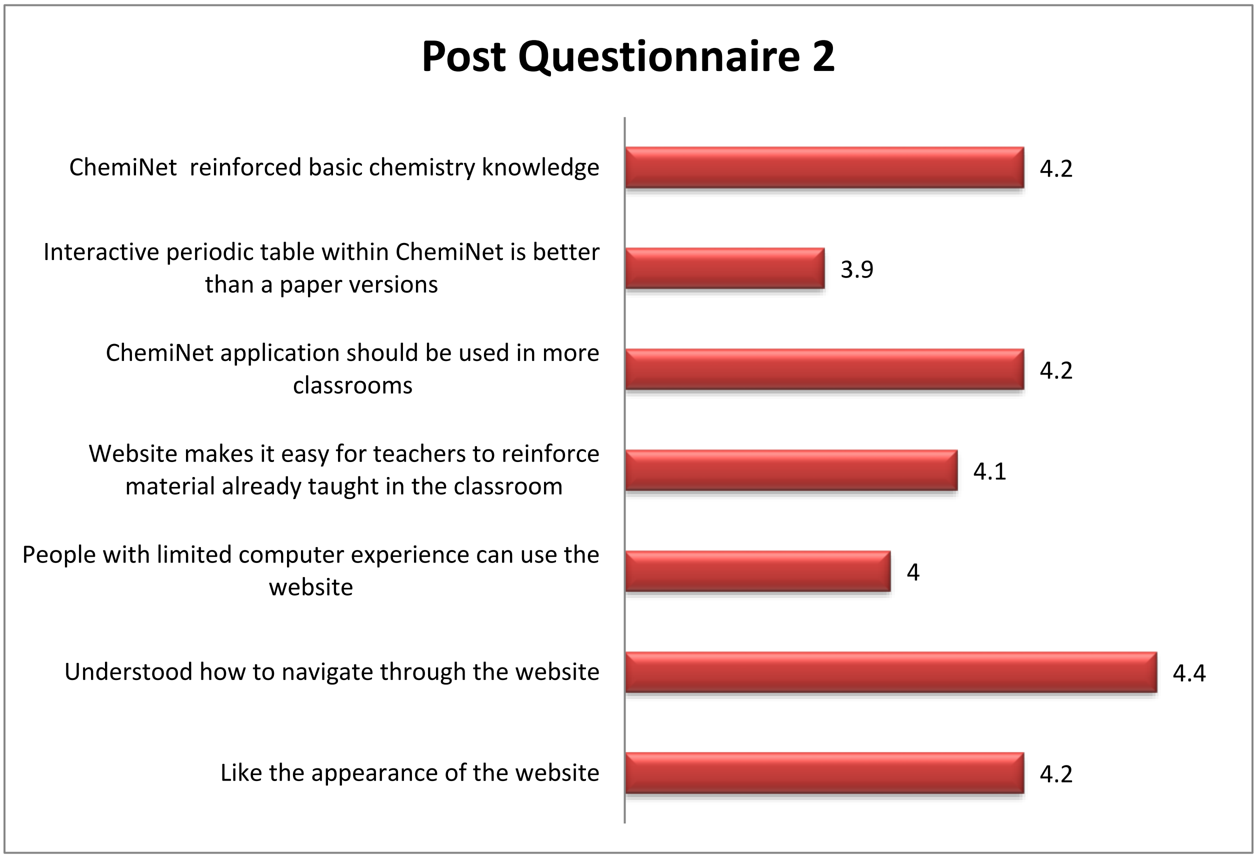


Figure 4.15: Post Questionnaire Online Learning Environments for Reinforcing Chemistry (*5pt scale)

The project goal was to have a rating of at least 2.5 in each category. Based on the analysis of the data, each category in the post questionnaires scored above a 2.5. Therefore, these findings support the goals of this research, which was to design and implement an online learning tool to support STEM education that is intuitive, exciting, easy to navigate, and ultimately providing a fun learning experience to the user. Furthermore, many of the users support this type of tool being used within their classroom, which demonstrates the users' acceptance for integrating technology within their core curriculum.

CHAPTER 5: PHASE II: WEB-BASED APPLICATION: COURSE BUILDER

A web-based was built as an extension of the ChemiNet applications for teachers and administrators to create courses and lessons to be displayed within ChemiNet. Course builder, a sub-system of ChemiNet, was implemented to allow teachers and administrators to add multiple courses and lessons that is able to be stored within a backend database. After a usability and functional design review of the ChemiNet project, the researcher found that interface was sufficient to support the display of course material however teacher and administrator had no way of updating that material within the ChemiNet application. This is done by providing administrative operations to the application where the administrator can add subjects and lessons dynamically by just filling in the content using a wizard like interface. Table 5.1 shows the differences between the two applications.

Table 5.1

Comparison Course Builder and ChemiNet

Features	ChemiNet	Course Web Builder
Application:		
is web-based	Yes	Yes
has the ability to view courses	Yes	Yes
has the ability to navigate to lessons	Yes	Yes
has the ability to add lessons dynamically	No	Yes
has the ability to add Subjects dynamically	No	Yes
has the ability to add more users	No	Yes
has the ability to retrieve forgot password	No	Yes

5.1 Functional Requirements for Course Builder

The following requirements were identified for the course builder application:

- FR1: The application shall be web-based.
- FR2: The application shall be interactive, meaning that the user is able to interact with the user interface and the system providing appropriate responses.
- FR3: The application shall validate user login.
- FR4: The application shall be able to register users.
- FR5: The application shall be able to retrieve forgotten password
- FR6: The application shall accommodate administrative operations and should have their own control panel.

- FR7: The application shall be dynamic, meaning that the user (admin) must be capable of adding Courses and Lessons.
- FR8: The application shall support lessons taught in traditional classroom sessions in different subject areas, meaning the application should function as a web-based learning environment that enables students to learn basic information concerning different subject areas.
- FR9: The application shall connect to a database to retrieve and store content.

The first requirement specifies the system be deployed on a web-based platform. This requirement was fulfilled by implementing the application in the following web-enabling implementation technologies: Java Server Pages (JSP), JQuery, Ajax, Java struts2 (Model-view-controller), Java Spring Framework, Java Hibernate (Object Relational model), and Java Maven (Library integrator).

The second requirement is that the application be interactive. The goal of the application is to allow the user to communicate with the computer through specified inputs and the computer respond by providing some type of output. Dynamic websites enhance the online learning experience compared to static websites. The system was built using JQuery and Ajax to fulfill this requirement. On using Ajax there is smooth transition between webpages.

Third requirement is to validate users. Validation is written on the server side for security purpose. The system validates that the username and password are entered, else an error message is displayed on the front page.

Fourth requirement is to register new users to the application. The system provides a registration option on the home screen. The user is directed to a page where they have to fill out a registration form to get registered as a user of the system.

Fifth requirement is to retrieve the password of registered users who forget their password. The user stores their email address, secret question and answer during registration. On clicking, forgot password on the login page, user will be asked to answer the secret question, upon entering the correct information, the system sends the password of the user to their email address.

Sixth requirement is to have administrative control panel. The admin should enter their username and password to enter the administrative control panel. The system contains a field for admin in the database to check whether a user is admin or not, so accordingly they would be directed to associated pages.

Seventh requirement is that the application shall be dynamic. The system fulfilled this requirement by giving administrator users the capability to add subjects and lessons as per the requirement.

The eighth and final requirement states that the application shall support lessons and courses. To fulfill this requirement, the application was built to support an interactive learning environment by allowing users to explore courses and the corresponding lessons.

5.2 Tools and Technologies

5.2.1 Java Server Pages (JSP)

Java Server Pages technology provides an easy way to create dynamic web pages. JSP uses a component based approach that allows web developers to easily combine static HTML for look and feel with java components for dynamic features. The simplicity of this component based model, combined with the cross-platform power of java allows a web development environment with enormous potential. Java Server Pages shows how to develop Java based web applications without having to be a hardcore programmer (Bergsten, 2003).

Java Server Pages (JSP) is a technology for controlling the content or appearance of web pages through the use of servlets, small programs that are specified in the web page and run on web-server to modify the webpage before it is sent to the user who requested it. Sun Microsystems is the developer of java. JSP is comparable to Microsoft's Active Server Page (ASP). Whereas JSP calls a program that is executed by the webserver, an ASP contains a script that is interpreted by a script interpreter before the page is sent to the user (Bergsten, 2003).

5.2.2 Java Struts 2 Framework

The Apache Struts 2.0 web framework is a free open-source solution for creating Java web applications. Web applications are different from conventional websites in that web applications can create dynamic response. Several websites deliver only static pages. A dynamic web application can interact with business logic and databases to customize a response ("Struts").

Web applications based on Java Server Pages sometimes blend database code, control flow code and page design code. In practice, it is found that unless these blends are separated, larger applications become difficult to maintain. One way to isolate concerns in a software application is to use Model-View-Controller (MVC) architecture. The model represents the database code, the view represents the page design code, and the controller represents the control flow code. The Struts 2.0 framework is designed to help developers create web applications that use MVC architecture ("Struts").

The framework provides three key components:

- A request handler provided by the application developer that is mapped to a standard URI.

- A response handler that transfers control to another resource which completes the response.
- A tag library that helps developers create interactive form-based applications with server pages ("Struts")

5.2.3 Java Spring

Spring framework is a Java platform that provides complete infrastructure that supports developing Java applications. Spring handles the infrastructure so that one can focus on the application. Spring enables to build applications from "plain old Java objects" (POJOs) and to apply enterprise services to POJOs. As an application developer, can use spring platform to make a Java method execute a database transaction without dealing with transaction APIs ("Spring Framework").

The following are some benefits the Spring framework can bring to a project.

- Spring can well organize middle tier objects, whether or not the developer chooses to use Enterprise Java Beans (EJB). Spring takes care of plumbing that would be left up to the developer if they want to use only Struts or other frameworks geared to particular J2EE APIs.
- Spring can remove the requirement to use custom properties file formats, by handling configuration in a consistent way throughout applications and projects. With spring, it only deals with the class's Java Bean property or constructor arguments. The use of invasion control and dependency injection helps achieve this simplification.
- Spring can abide good programming practice by dropping the cost of programming to interfaces, rather than classes.

- Spring is designed such that applications built with it depend on as few of its APIs as possible. Most objects in Spring applications have no dependency on Spring. (R. Johnson, 2005)

5.2.4 Java Hibernate

Hibernate is an Object-relational mapping (ORM) library for Java language, providing a framework to map an Object-oriented model to a traditional relational database. Hibernate solves object-relational impedance mismatch problems by replacing persistence-related database accesses with high level object handling functions. Hibernate is a free open source software that is distributed under the GNU General Public License lesser ("Java Hibernate").

Rather than using byte-code processing or code generation, Hibernate utilizes runtime reflection to define the persistent properties of a class. The objects to be persisted are defined in a mapping document, which serves to describe the annotations and persistent fields, as well as any subclasses or proxies of that object. The mapping documents are compiled at application startup time and provide the framework with required information for a class. Additionally, they are used in support operations, such as creating stub java source files or generating database schema. The primary feature of Hibernate is mapping from Java classes to tables. Hibernate also provides querying data and data retrieval facilities. Hibernate generates SQL calls and relieves the developers from object conversion and manual result set handling, keeping the application portable to all SQL databases, delivering portability of database with very little performance overhead ("Java Hibernate").

5.2.5 Java Maven

Maven, a Yiddish word meaning "accumulator of knowledge", was started as an attempt to simplify the build processes in the Jakarta Turbine project. There were numerous projects each with own Ant build files that were slightly diverse and JARs were checked into CVS. The Maven developers wanted a standard way to build projects, a clear definition of the project, an easy way to publish information of the project and a way to share JARs across numerous projects. The result is a tool that can be used for managing and building Java based project ("Apache Maven Project").

The primary goal of Maven "is to allow developer to comprehend the complete state of a development effort in the shortest period of time". Maven attempts to deal with:

- Making the build process easy.
- Providing uniform build system.
- Providing guidelines for best practices development. ("Apache Maven Project")
- Allowing transparent migration to new features.

5.2.6 Ajax

Ajax (Asynchronous JavaScript and XML) is a method of building interactive web applications that process user requests immediately. Ajax combines different programming tools like JavaScript, dynamic HTML {DHTML), Extensible Markup Language (XML), Microsoft object, XMLHttpRequest, Cascading Style Sheets (CSS), and Document Object Model (DOM). Ajax allows content on webpages to update immediately when a user performs action, unlike HTTP request, during which users must wait for a new page to load. For example, a weather forecasting website could display local conditions on one side of the page without loading the entire page after a user types in a zip code.

5.2.7 Tomcat

Apache Tomcat is an open source software implementation of the Java Servlet and JavaServer Pages technologies. The Java Servlet and Java Server Pages specifications are developed under the Java Community Process. Tomcat is a container which runs .war files and our project deploys a .war file, so that is why the researcher use a Tomcat server.

5.3 Design

A software design is a key component of the development life cycle when designing web-based applications. Firstly, design patterns were chosen before the project started. Two design patterns were chosen for this project: MVC and singleton design pattern.

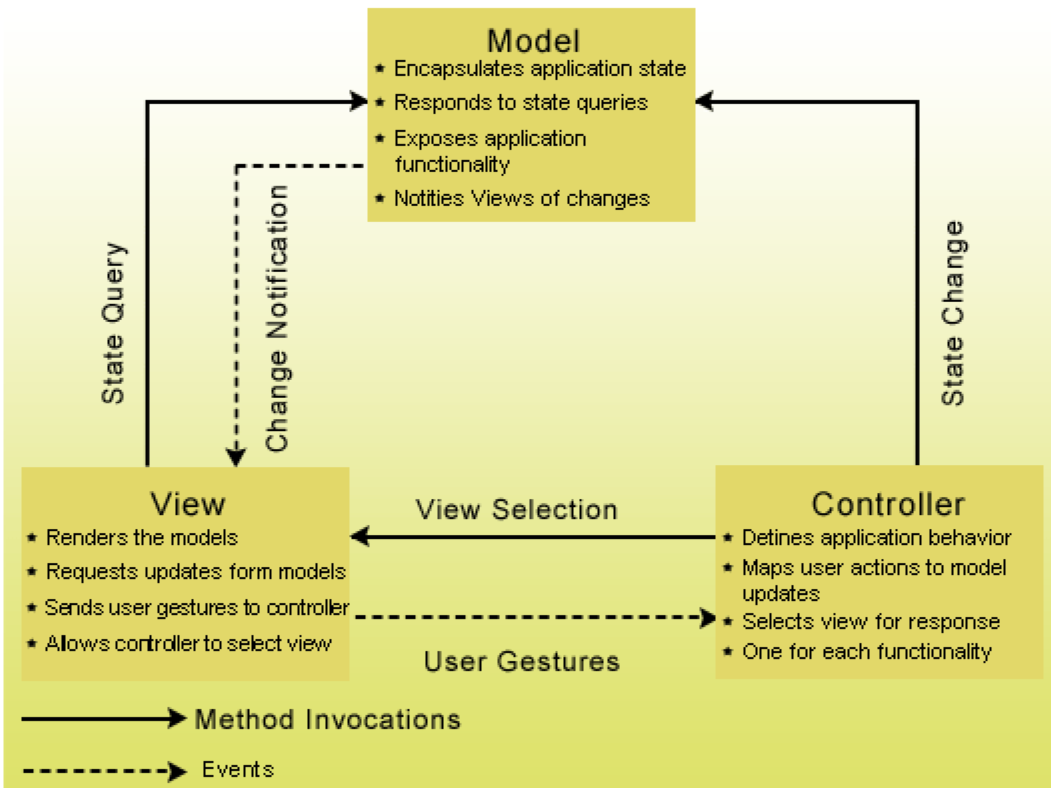


Figure 5.1: MVC Architecture Diagram

5.3.1 MVC Design Pattern

MVC stands for Model View Controller. It is a classical design pattern in applications which needs a separation between their business logic and view and the control flow. MVC pattern isolates the application logic from the User Interface. The design pattern is divided in three parts:

1) Model: This component manages the information and notify observes if there is change in the information. It represents the data on which the application operates. The model provides persistent storage of data, which manipulated by the controller.
2) View: The view displays the data, and also takes user inputs. It extracts the model data into a form and displays to the user.
3) Controller: The controller handles all the requests coming from the view. The data flow of the application is controlled by the controller. It forwards a request to the appropriate handler. Only the controller is responsible for accessing model and extracting the data to various UIs ("Java Model View Controller (MVC) Design Pattern," 2010).

This design pattern was used to isolate the dependency between the control flow (control), user interface (view), and database code (model). Such a pattern is able to make the project scalable for the future, meaning to add more functionality to the project.

5.3.2 Singleton Design Pattern:

Singleton pattern ensures a class has only one instance, and provides global point of access to it. Sometimes, the application needs one, and only one, instance of an object. Additionally, global access and lazy initialization are necessary. Singleton pattern is achieved by making a class of the single instance object responsible for initialization, creation, access, and enforcement ("Singleton Design Pattern").

In our project singleton pattern is used with the help of Spring framework. The researcher used the singleton pattern for database connection (because database should only be connected once and should be global) and for importing services from business service classes to action classes.

5.3.3 Architecture:

The architecture of the system is depicted in Figure 5.2. A request is sent by a user using a JSP through the web server. The JSPs have forms which posts an action name in the action attribute of the form tag. Struts.xml maps the action name to the java bean; this bean is a reference from the Spring framework. The Spring framework maps the bean to the action class. The interceptors are fed to the Action classes which decide the output string. Action classes have Business Service Classes when it needs a database connection. A database session is serviced by using Hibernate. When an action class returns an output string, struts.xml maps the string to the resulting JSP. The resultant JSP thus gets returned to the user using the computer. Struts2 follows MVC design pattern and Spring framework makes sure that singleton pattern is followed.

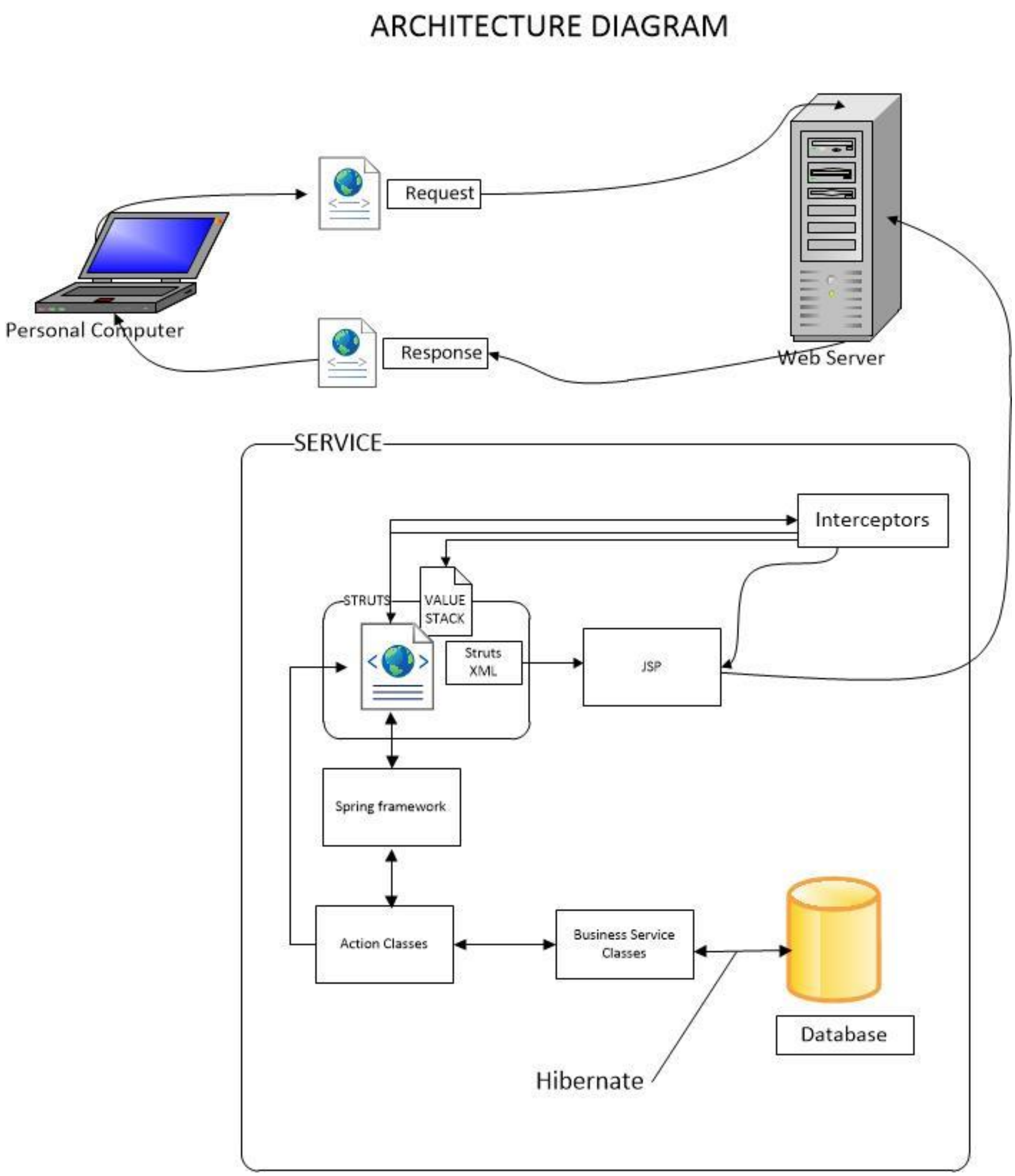


Figure 5.2: Architecture Diagram

5. 4 Application Overview

5.4.1 How does the system work?

The application has two database tables; one is admin-actions table and the other is credentials table. Credentials table stores username, password, First name, Last Name, secret question, secret answer and Admin fields. Admin-actions table stores SubjectName, LessonName, PageNo, ImageLocation, Title, Subtitle, and Description.

Credentials table is used for user validation and has a primary key comprising of username and password. A user will be authenticated only if the username and password matches to that in the database. An admin can be identified by looking at the admin field in the Credentials table (admin field can store 0 and 1, 1 returns to admin and 0 to user). User and Admin have different pages. This table is also used for creating new users and retrieval of forgotten password.

5.4.2 Adding New Subjects

When an admin logs in with the credentials, they are directed to the admin panel page. The function of an admin is to add subjects and lessons. Each subject can have any number of lessons and each lesson can have any number of pages. A page of a lesson has an image, description, Title and a Subtitle as entry fields. All the additions are done dynamically (single JSP page is used to add the entry fields to the database). When an admin wants to add subjects, they click the ‘add lessons’ option, and Ajax loads the subjects asynchronously from the database in a drop box. On selecting the “other” option and clicking go, the system asks the admin to enter the subject name for which they want to add lessons. Once admin clicks on ‘submit’ after entering the subject name, the system directs the admin to add lesson page of that particular subject. The page consists of a form where the admin enters title, subtitle, chooses an image file, and a description area to enter the content of that lesson. If the admin wishes to add more lessons they can click the ‘add more pages’ option, or if they wish to submit the lesson they can click the ‘submit lesson’ option. In the database a page can be identified with a unique composite key of Subject name, Lesson name and page number. While storing a page, the system stores Subject name, Lesson name and page number (Remains 1 the first time, automatically incremented on clicking add more page option).

5.4.3 Adding Lessons to Existing Subjects

If an admin wants to add lessons to an existing subject, they click on the ‘add lesson’ option in the admin page, Ajax loads a dropbox which contains the list of existing subjects (similar to Add new Subjects) in the database. Admin chooses the subject to add a new lesson and clicks on go, the system directs the admin to add lesson page and the rest is the same as discussed in the adding new subjects section.

5.4.4 View Lessons for Admin and User

The admin user can click on view courses option and a user logs in with their credentials and they are able to be directed to view courses page. First, user/admin choose the subject they wish to view the courses, system communicates with the database and returns a list of lessons to the user/admin. The user/admin chooses the lesson and the system directs them to that particular lesson’s first page. As discussed earlier, each page has a title, subtitle, an image, and a description area. Along with the fields the user/admin has option to click on next page or on home page button. The logic of the view course page is, when a user clicks on a particular lesson, first the system calculates the number pages a lesson and the system automatically searches for the first page with the same subject name and lesson name. When the user clicks on next option, the content of the next page will be loaded (page will be incremented to retrieve the content of the next page). The next button disappears and only previous and home button is visible when the user reaches the last page. Similarly, for the first page, previous button won't be visible.

5.4.5 Use Case Diagram

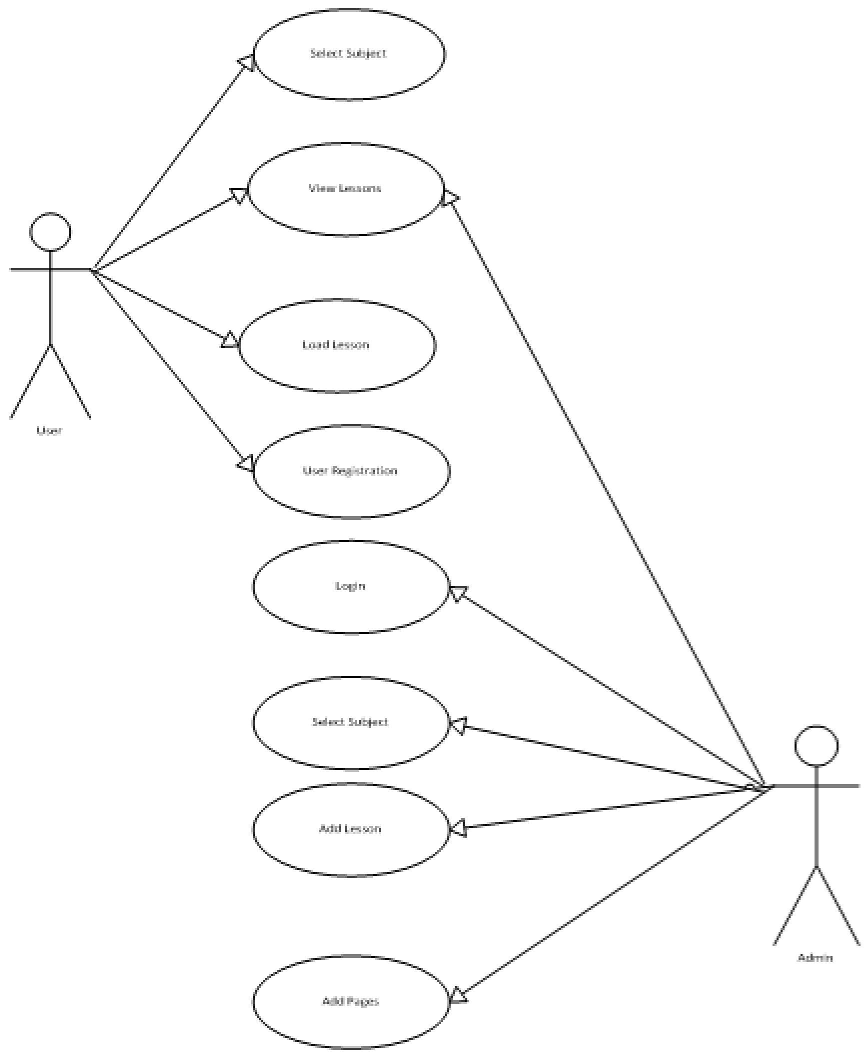


Figure 5.3: Course Builder: Use Case Diagram

5.4.6 Sequence Diagrams

Once the system functions were outlined, the next aspect of the system that needed to be documented was how the system responds to task initiate by the student user. To illustrate the interaction between the system and the user, several system sequence diagrams were created. These sequence diagrams show the optimal response output based on input by a student user or administrator who is a teacher. The following are the sequence diagrams for adding lesson (Figure 5.4), view lesson (Figure 5.5), user registration (Figure 5.6) and forgotten password (Figure 5.7).

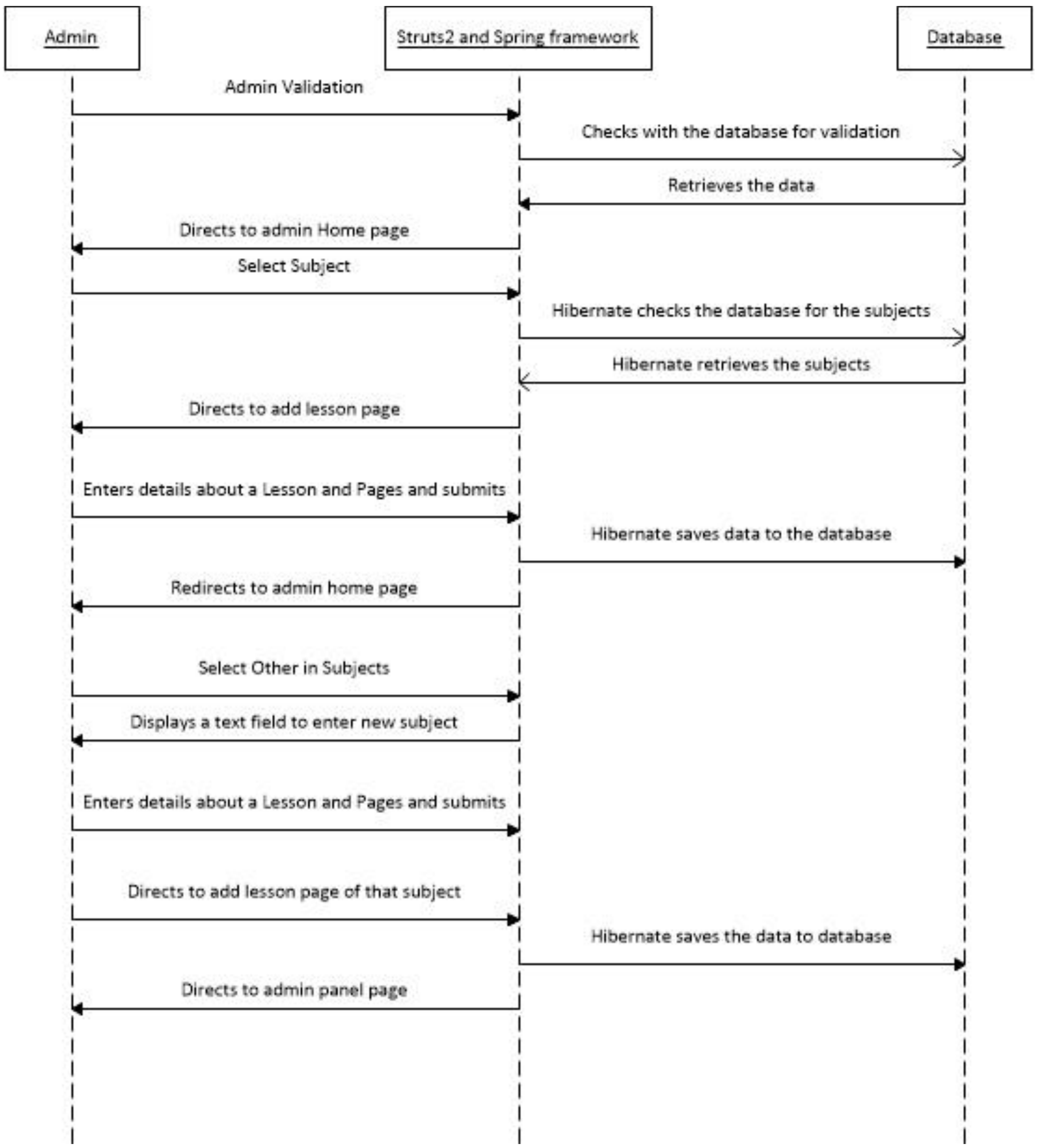


Figure 5.4: Course Builder: Admin Sequence Diagram

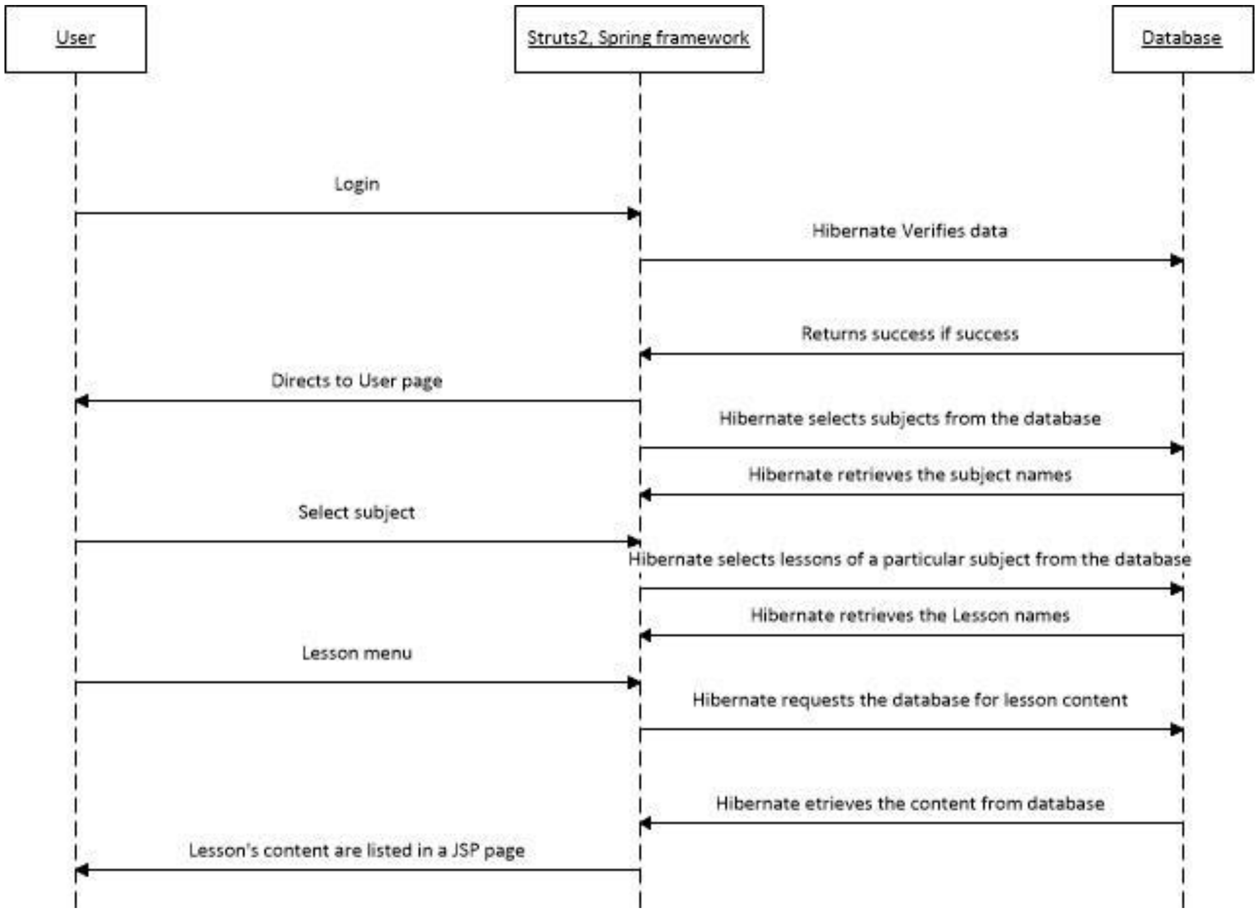


Figure 5.5: Course Builder: User and Admin View Sequence Diagram

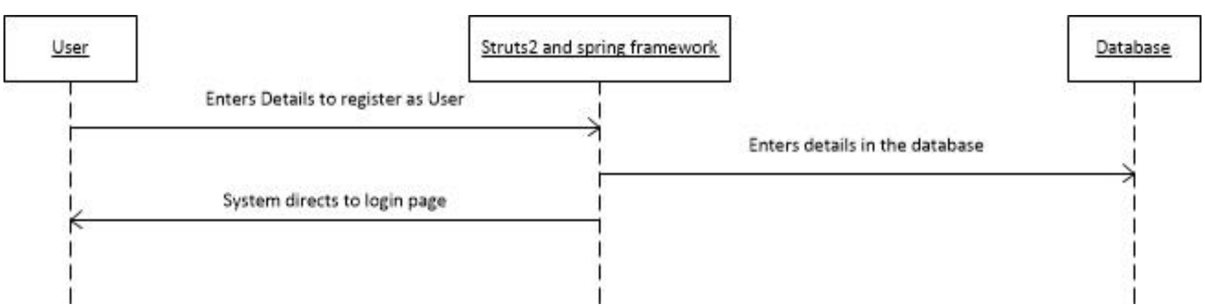


Figure 5.6: Course Builder: User Registration Sequence Diagram

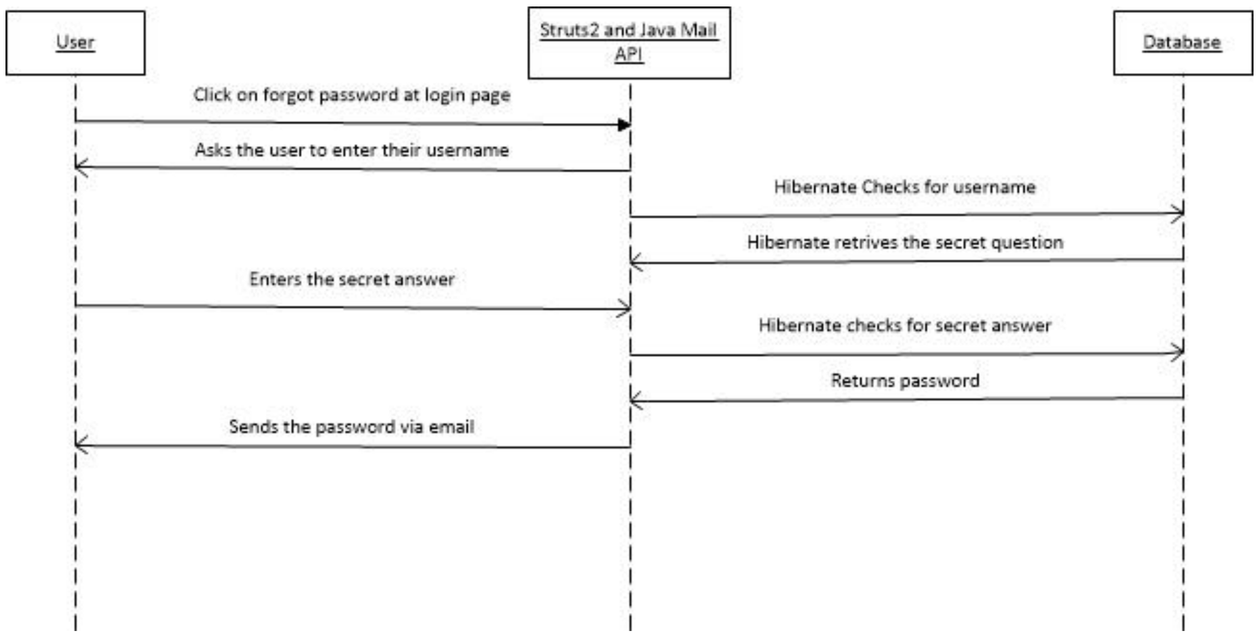


Figure 5.7: Course Builder: Forgot Password Sequence Diagram

5.5 Results and Analysis

5.5.1 Manual Functional Testing

Functional testing is an extensively accepted testing practice and is a part of any testing project which makes sure that the required functionality is working properly before the deployment of the system or application. Even though there are many automated tools in the market which support functional testing activities, companies still struggle to achieve the level of quality they were looking for in their products. This is because they overlook the importance of the Manual Functional Testing. In the current testing market, over 70% of activity is still manual, with the remaining 30% being automated. This shows the importance of an organized Manual Function Testing practice. Manual Functional Testing is a black-box testing method that involves converting the Functional Requirements of the product into Manual Functional Test Cases which will provide a swift and objective way to assess the status of expected functionality.

The test cases are then used to closely compare the Functional Requirements with its actual observed behavior, and then provide a detailed analysis of any discrepancies (“Manual Functional Testing”). This system is followed by MirrorTech Company (“Manual Functional Testing”).

5.5.2 Manual Database Testing

Another test the researcher used to analyze this project is Database testing. It can be done manually by observing the operations which are done in the front-end are effected on the back-end. This test is done by 360logica Company (“Database Platform Testing”).

The above strategies were used and a test case scenario was created for the requirements of the project. The researcher verified and validated the front-end with entries effects on the back-end.

5.5.3 Adding a Subject and Lesson

One of the requirements of the project is to add a Subject dynamically. To evaluate the Course Builder interface, the researcher created a scenario where an admin adds a lesson to the chemistry subject.

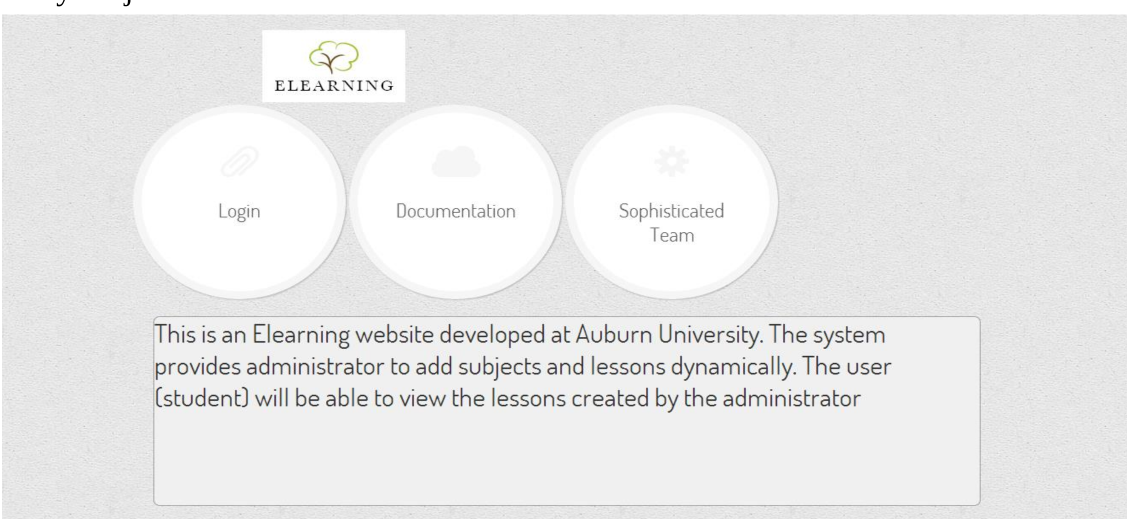


Figure 5.8: Course Builder: Home Screen

The above figure shows the home screen of the application. The admin clicks on the login button in order to add a new Chemistry lesson.

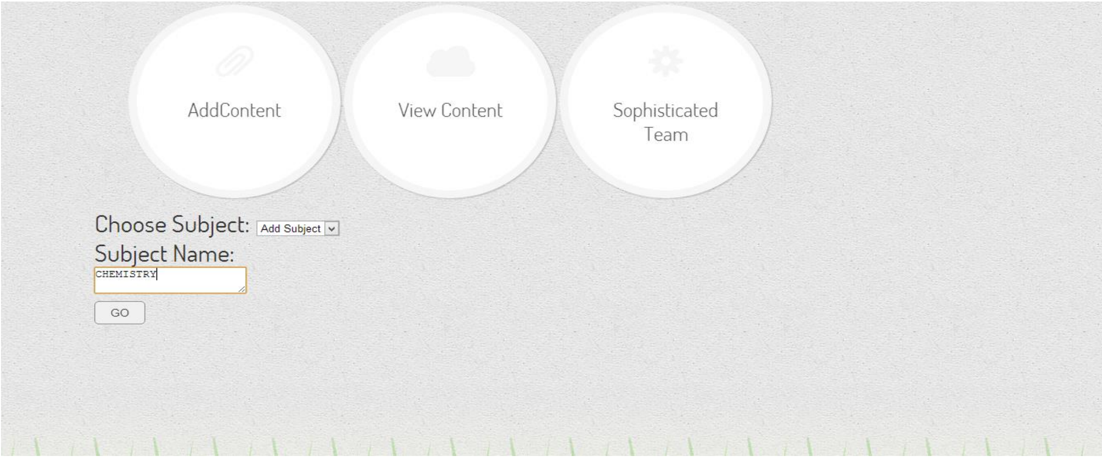


Figure 5.9: Course Builder: Admin Panel

Admin logs into their page using their credentials. The administrator clicks on 'Add Content' button; system asks for selecting a subject. Since there is no CHEMISTRY option in the choose subject list, the admin is asked to enter the subject name. Admin enters CHEMISTRY and clicks on 'GO' which is shown in the picture.

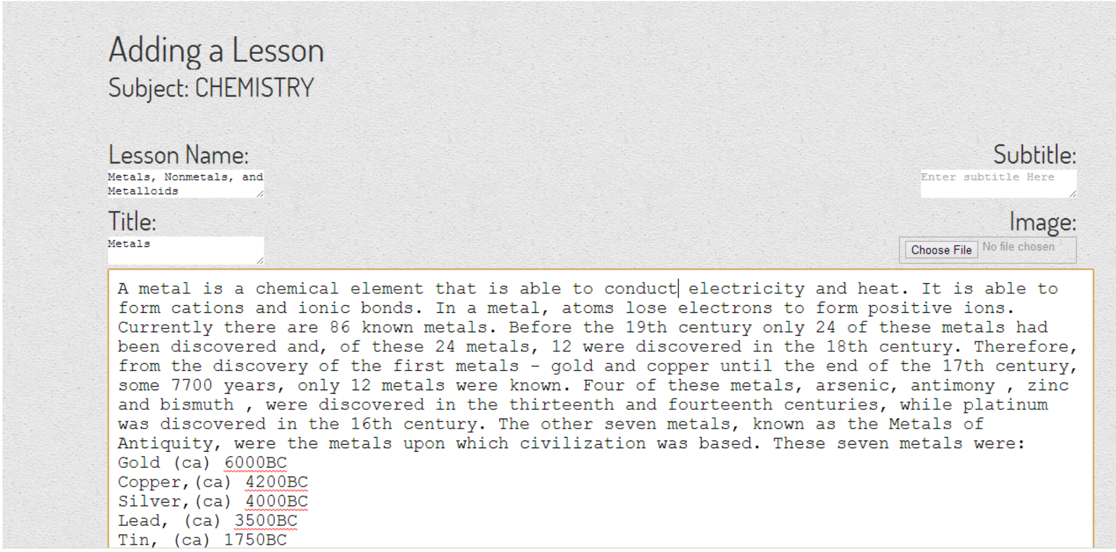


Figure 5.10: Course Builder: Add Lesson Page

Once the admin clicks on go, the system directs the admin to “Adding a Lesson page”, where the system asks for Lesson name, Title, Subtitle, Image and description. Admin enters all the details as shown in the figure. And it is optional for the admin to upload an image.

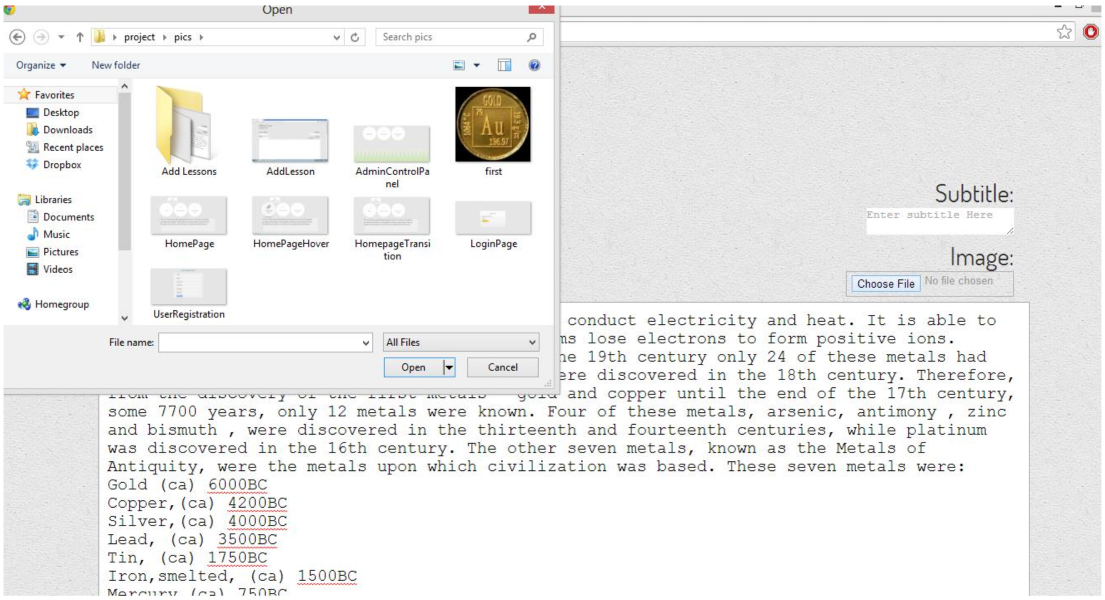


Figure 5.11: Course Builder: Adding an Image in a page

Per our requirement this page has a picture, an image was added and this is shown in the above figure. Once the page is filled with required information, the system provides admin to add more pages of submit the lesson. But as per the requirements, more pages were required to be added to this lesson.

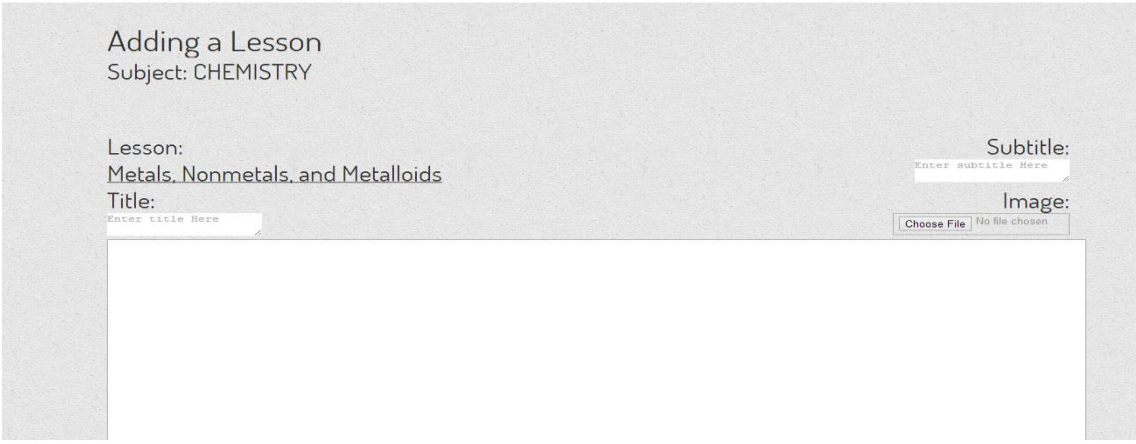


Figure 5.12: Course Builder: Adding Page 2

As shown in Figure 5.12, page 2 of that particular lesson can be added. Admin clicks on add pages until the last page is added to the system and clicks on submit button once all the pages have been added.

The entries added on the front-end can be seen in the back-end by checking the database. The following diagram shows the database entries, thus making sure that the data entered in the front-end has correctly reached the back-end. The diagram shows the entries that were entered into the database when it was entered by the administrator on the front-end.

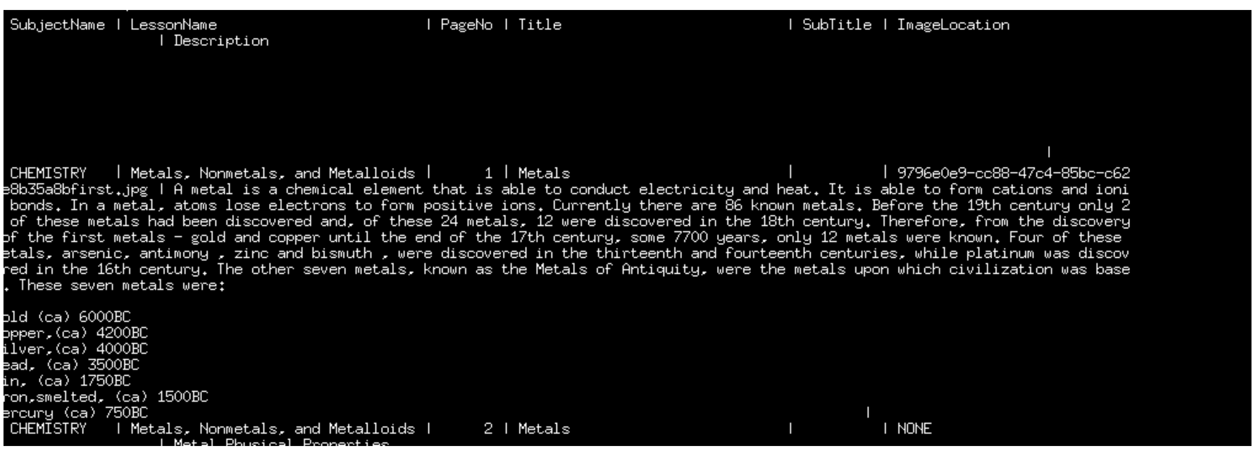
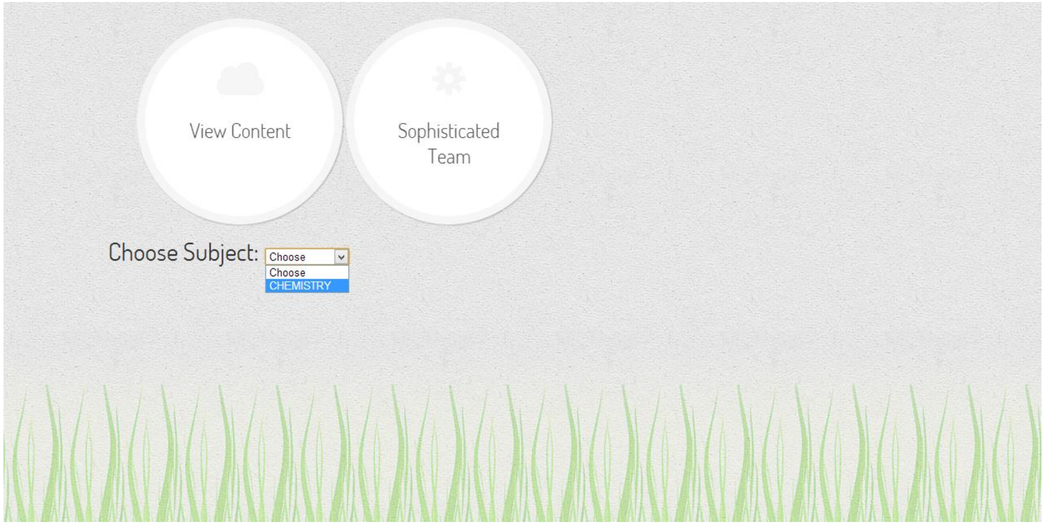


Figure 5.13: Course Builder: Database table after entry of data

5.5.4 View Lesson

Another requirement of the project is to allow users to view the lesson added by the admin. Since the admin has added a lesson into CHEMISTRY, the researcher simulate this requirement to view the CHEMSITRY lesson. First, the user logs into their page with entering their credentials in the login page. The user selects the 'view course' button and chooses CHEMISTRY from the "Choose Subject" drop down menu, as shown in Figure 5.14. The system searches for lessons in the database and displays the lessons, which is shown in Figure



5.15.

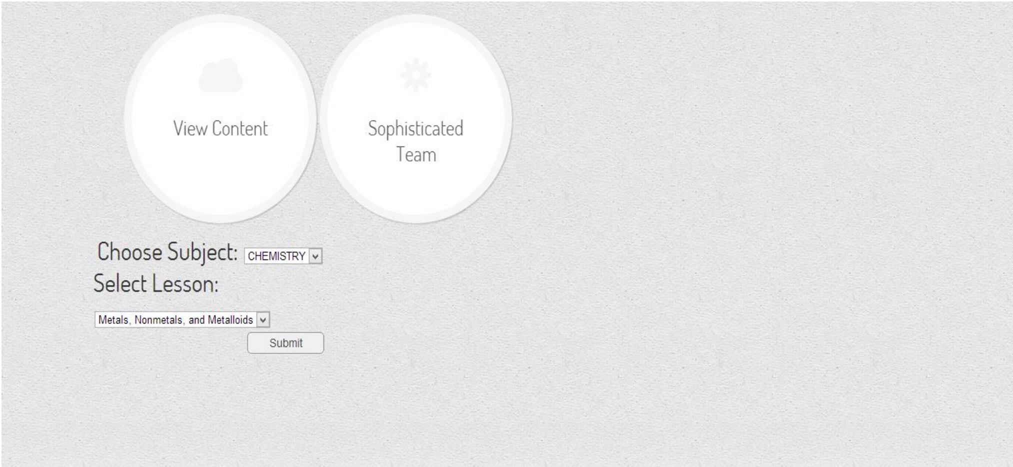


Figure 5.14: Course Builder: User Home Screen

Figure 5.15: Course Builder: User Select Lesson

The user selects on the lesson that is listed and clicks on submit. The system loads the first page of the selected lesson and is shown in Figure 5.16.

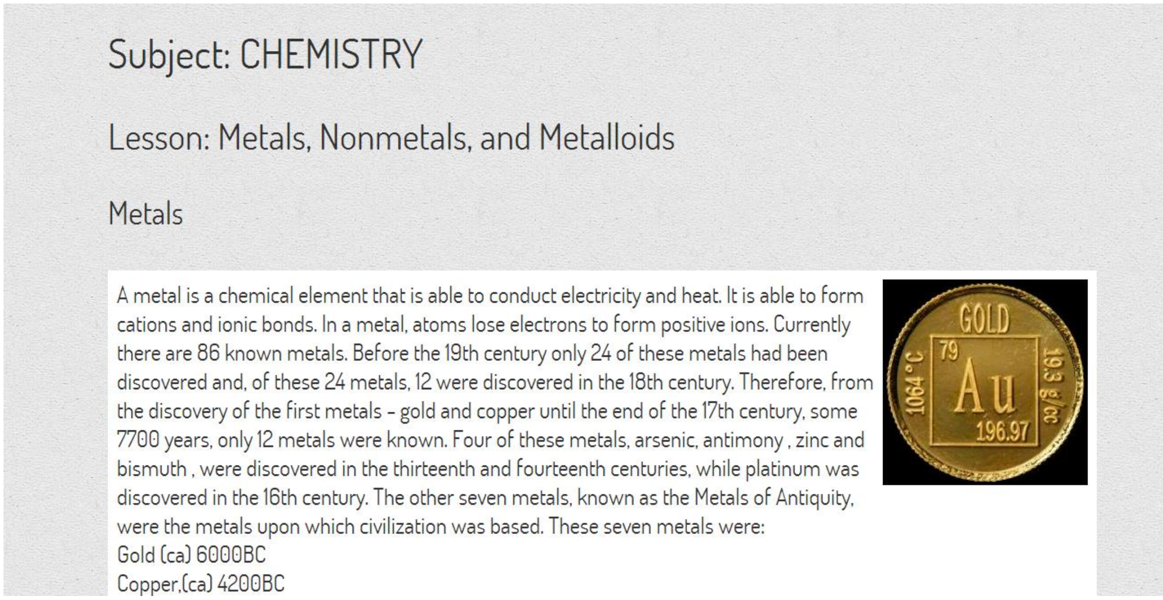


Figure 5.16: Course Builder: User Viewing Lesson

CHAPTER 6 PHASE III: COLORS: COLLABORATIVE ONLINE LEARNING OPPORTUNITIES TO REINFORCE STEM

With technology becoming a necessity in the classroom and playing an important role in preparing young people for success there need to be usable systems more widely available for the purpose of informal learning. The use of technology allows teachers to display more information in creative forms and enhance student learning. Web-Based Informal Learning environments enable students to interact and engage with course material that they may not have access to within a traditional learning environment. Web-based environments are able to provide this flexibility. Today's generation of students can write entire papers without ever reading a book or touching a pen or piece of paper. They do this by utilizing the latest technology and accessing web resources. By making online course tools easy to use, teachers can build out resources from lesson plans within an online environment to support students in their classroom as well as share and open up their lessons to students aboard who may not have access to this particular course within their school.

Furthermore, the interactivity provided by modern web design provides a fun way to learn. Web-based courses can take students on a journey without the student leaving their home/school. Students are drawn into material that is exciting to them. Students also excel when they are learning, rather than simply being taught. E-learning can be delivered and supported using a variety of electronic media. Students can use their tablet, smartphone or computer to access web-based courses. In most instances, additional software is not needed.

Therefore, web-based informal learning environments provide the ideal supplement to traditional education. Making web technologies one of the most efficient ways to create and deliver individualized, comprehensive subject specific content.

The Collaborative Online Learning Opportunities to Reinforce STEM (COLORS) website is designed to introduce students to the central ideas of computing and computer science as well as other STEM related subjects. The main purpose of this design was to create a system that will support students in taking courses not offered through their school as well as provide teachers in their classrooms additional resources and aids that would support learning. The goal of the project is to instill ideas and practices of computational thinking and to have students engage in activities that portray the power of STEM. The main goal is to engage students in the creative aspects of the field. Students will gain some experience in STEM concepts and have the ability to find problems and solutions in a world that rely on technology. Also, this project aims to provide a platform to aid teaching in schools through effective new high school curriculum in computing through various forms of engaging media that will encourage a student's pursuit to STEM fields.

This chapter outlines in detailed the refined requirements for the development of the system based on the initial requirements analysis and system implementation of the ChemiNet application (Phase I of research) and the CourseBuilder system (Phase II of research). The implementation has been outlined with use case diagrams design standards to capture requirements and sequence diagrams. Also included are low-fidelity prototypes of the COLORS application created during the interface design process in order to show raw presentation of our ideas to Expert evaluators throughout the design process. This process allowed experts to comment on the usability of the system and identify flaws in the design before implementation of the final system. One of the issues discovered during the design process is that many courses layouts do not include lessons. The information is grouped in topics which enable a clearer and clean interface appearance.

6.1 Requirements

The initial requirements for the COLORS application were gathered based on the feedback provided through post questionnaire evaluations from the target population of the ChemiNet and CourseBuilder applications. Table 6.1 outlines the preliminary system requirements for the COLORS application. The preliminary requirements addressed the role of the user and admin as well as any overarching system requirements.

Table 6-1

Preliminary System Requirements

- User shall have the ability to logon - User shall have the ability to search for course based upon subject and grade level (target level) - User shall have the ability to enroll in course - User shall have the ability to view lesson - User shall have the ability to view course material - User shall have the ability to view quiz
- System shall store quiz result - System shall display quiz result - System shall display course slides/articles/videos/images. - System shall track user quiz scores - System shall track courses user has completed - System track courses user has started but have not completed - System track courses user is enrolled in
- Admin user shall have the ability to register - Admin user shall have the ability to login - Admin user shall have the ability to create a course with video/text/images/etc. - Admin user shall have the ability to save content - Admin user shall have the ability to publish content - Admin user shall have the ability to edit content - Admin user shall have the ability to create quizzes for lessons

The aim of the COLORS project was to produce an interactive and adaptive-based application to support informal learning. The preliminary requirements were refined to include system, security and interface requirements for the COLORS application for the student user. Table 6-2 displays the final requirements for the COLORS application.

Table 6-2

Final Requirements for COLORS Application

Project Requirements	
System Requirements	
Req. 1.0	System shall allow user to register for the site.
Req. 1.1	System shall allow user to login to site.
Req. 1.2	System shall allow material to be easily accessible.
Req. 1.3	System shall allow users to view course catalog.
Req. 1.4	System shall allow users to enroll in courses.
Req. 1.5	System shall provide a medium for informal learning.
Req. 1.6	System shall provide access to lessons, videos, quizzes, and other course resources.
Req. 1.7	System shall be flexible to allow for change
User Requirements	
Req. 2.0	User shall have the ability to register for the site.
Req. 2.1	User shall have the ability to login to site.
Req. 2.2	User shall have the ability to view all courses offered in system.
Req. 2.3	User shall have the ability to access account information.
Req. 2.4	User shall have the ability to access course.
Req. 2.5	User shall have the ability to enroll in course.
Req. 2.6	User shall have the ability to access lessons, videos, quizzes and other course resources.
Req. 2.7	User shall have the ability to view lessons, videos and other course resources.
Req. 2.8	User shall have the ability to take quiz.
Req. 2.9	User shall have the ability to view quiz score.
Req. 2.10	User shall have the ability to download videos
Security Requirements	
Req. 3.0	System require user to enter username/password in order to access system.
Req. 3.1	System should provide secure access to course information.
Req. 3.2	System shall provide role-based access to material.
Interface Requirements	
Req. 4.1	System shall provide an interface that is user-friendly.
Req. 4.2	System shall provide an interface that is easy to navigate.
Req. 4.3	System shall provide an interface that is neutral in color.
Req. 4.4	System shall provide an interface that is intuitive in nature.

The final set of requirements address all major components of the application in order to provide a smooth user experience. These requirements were validated based upon expert and user evaluations of the system.

6.2 Software Design Process/Conceptual Model of COLORS

To fully understand the expectations for a web-based system for middle and high school aged students that is both functional and aesthetic appealing the researcher used a general software design approach.

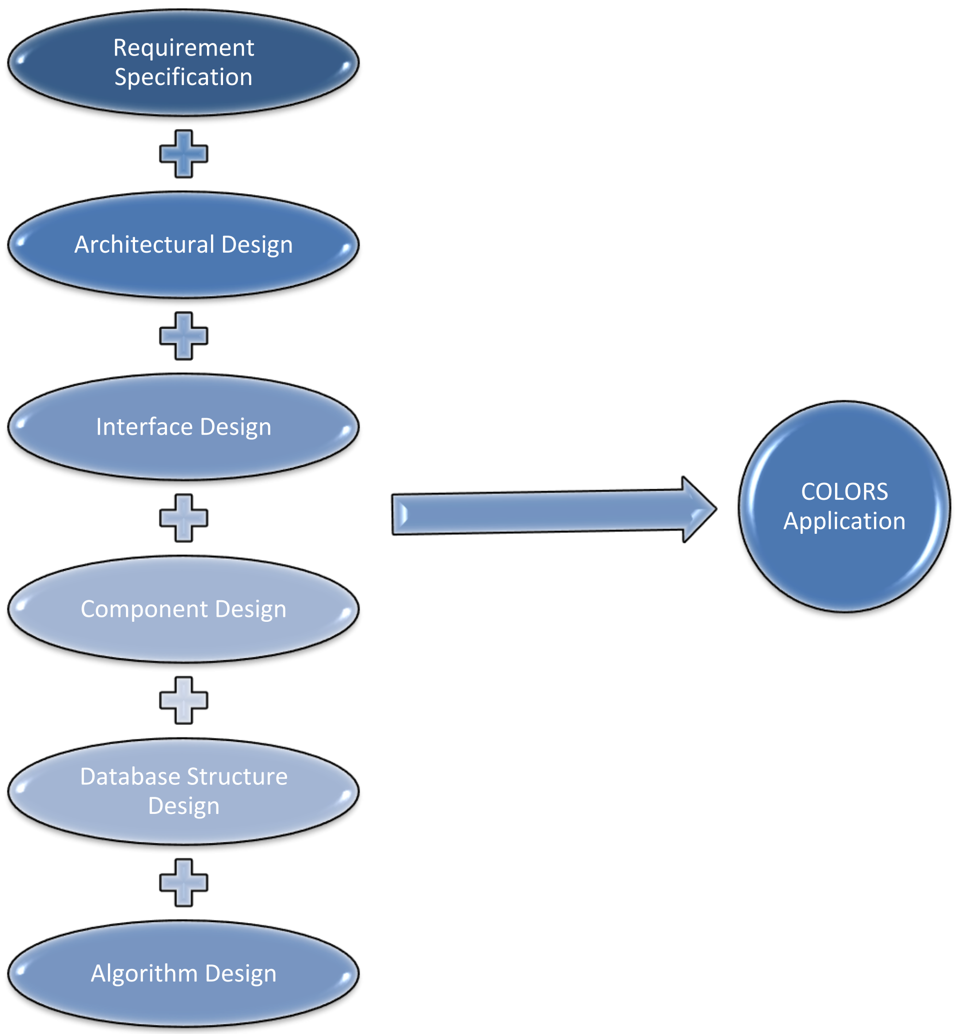


Figure 6-1: General Software Design Process

The COLORS applications will be connected to a database to facilitate to easy access of user information. The representation of the ERD diagram for the database is in Figure 6-2 and Figure 6-3. The database will be used to store lessons, quizzes, activity information, and articles. Figure 6-4 shows how the database will interact with the application. The database was setup in a relational model that encompasses several data tables, columns, and unique identifiers. The database was designed in such a way to allow quick retrieval and updates to course data.

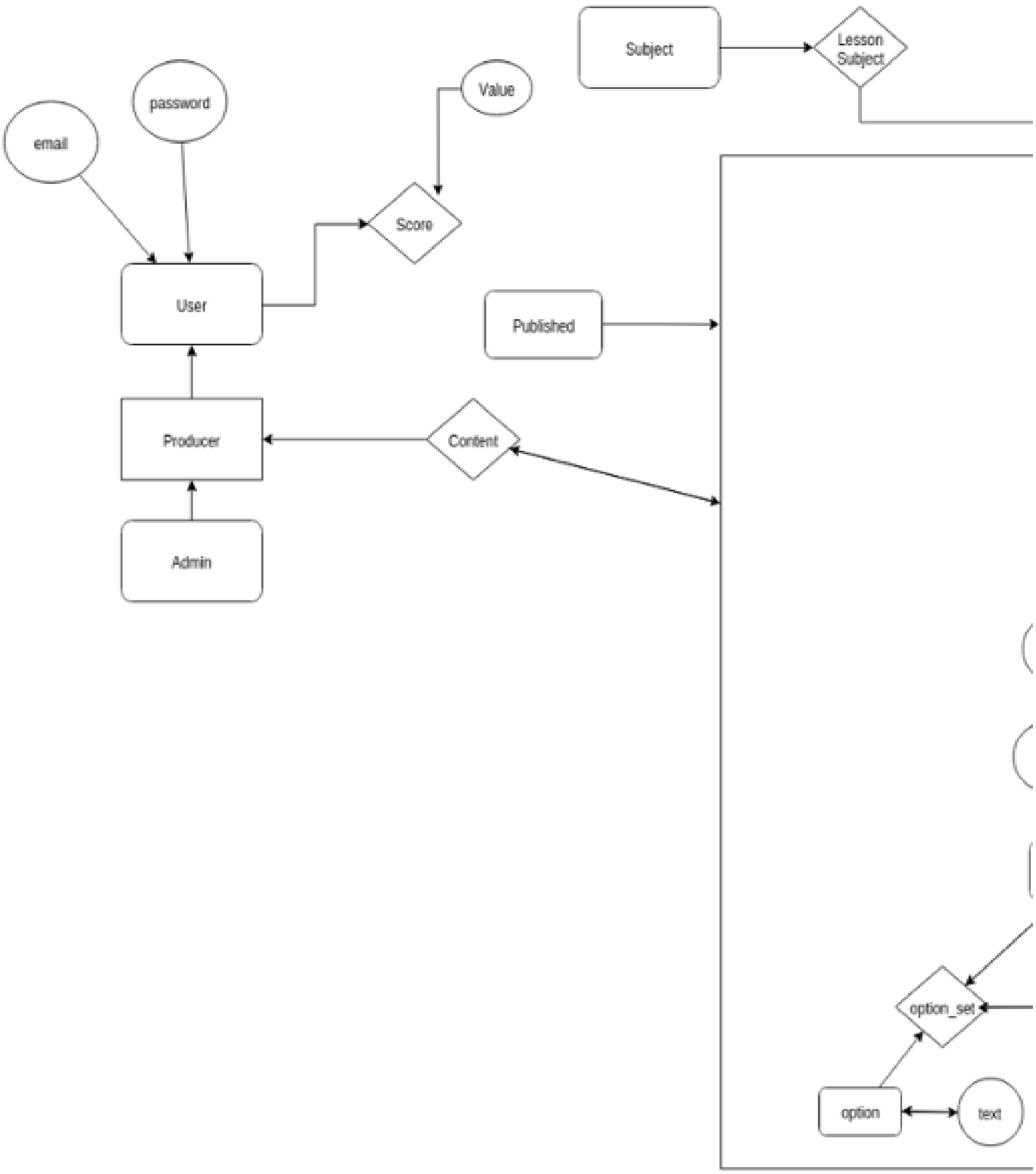


Figure 6-2: COLORS Database ERD Diagram (Part I)

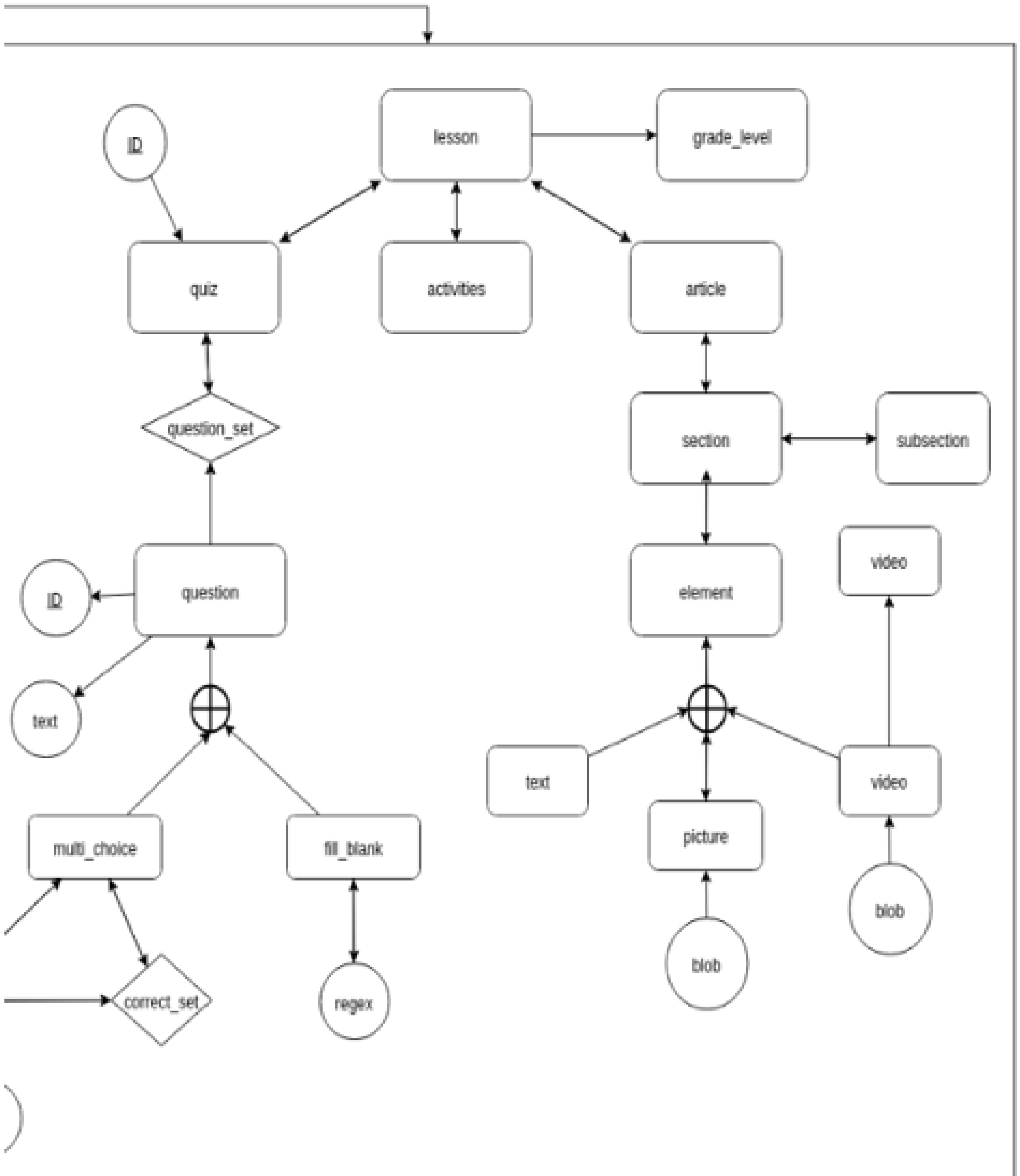


Figure 6-3: COLORS Database ERD Diagram (Part II)

Figure 6-3 also shows how the user interacts with the COLORS application. The user interacts with the COLORS application directly through a web interface. Once actions are completed by the user, if necessary, information is saved or retrieved from the database.

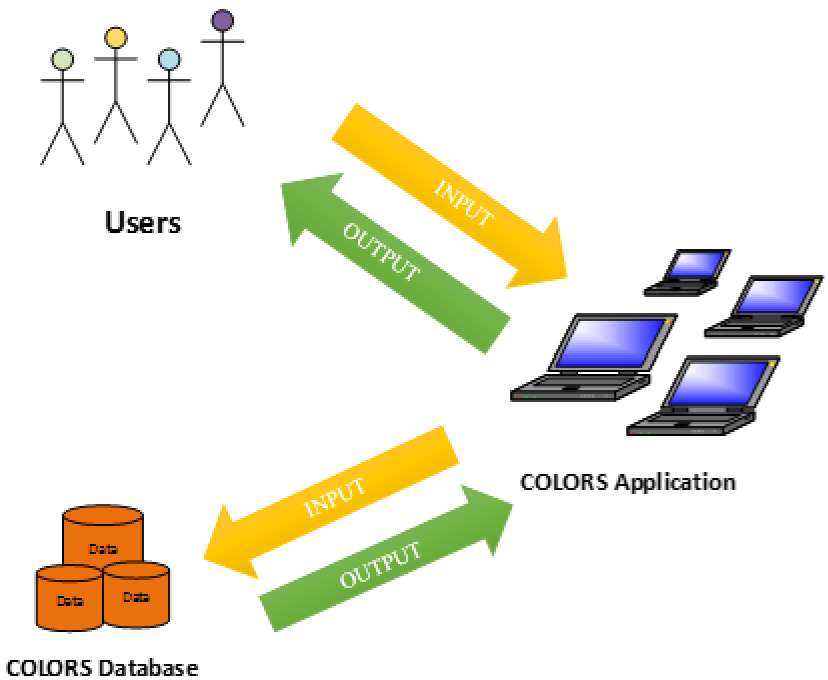


Figure 6-4: Application and Database Interaction

By having an adaptive and interactive interface a user can interact directly with elements on the screen to quickly gain access to the material they are looking for within the system. Within the learning environment, students can revisit material over and over in order to master various concepts. There is no limit on the amount of times they can take a particular course. The web-based environment also offers a number of quizzes in order to test the knowledge of the user. Having multiple quizzes within the environment allows the student to be expose to a variety of questions and topics for a particular subject. These quizzes can be designed by the teacher and includes a variety of questions types such as multiple choice and/or true/false.

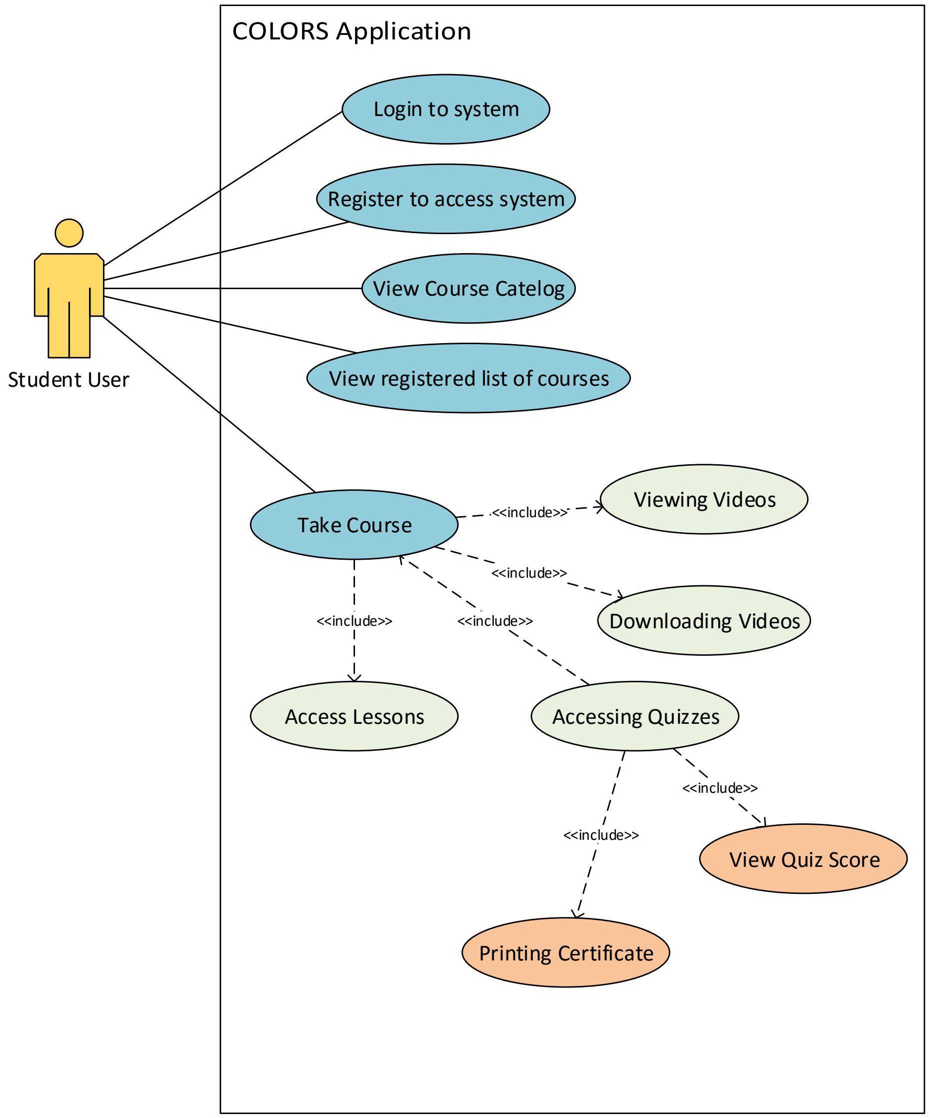


Figure 6-5: Use Case Diagram for COLORS App

In creating COLORS, the research goal was to create a system that would meet a minimum set of usability requirements in a tool to support informal collaborative learning. To achieve this goal, a system was built that contains one course with the possibility to include several courses for students to register and complete. To explore the system design, use cases were built to document the general and specific functions that will be incorporated into this web-based learning environment.

Detailed analysis and design of the system was accomplished through an object oriented decomposition of the system using Unified Modeling Language. The analysis begins with use cases, which describe the system in terms of functionality. The use case diagram in Figure 6-5 shows how the user will interact with the system and what they can do with the system. The use case allowed us to break the system down into components. There are several actions the user can perform from within the COLORS application. If a user does not have access to the COLORS application, they can register for the applications quickly and simple. Allowing the user to easily access the course content without making it frustrating to enter tons of data up front was the goal of the registration design page. The student can actor can perform all the tasks listed in the use case.

Use Case 1: Student Interaction with COLORS

The use case in COLORS for student interaction are defined as follows:

- Login to System
- Register Access System
- View Couse Catalog
- View Registered List of Courses
- Take Course
    - Access Lesson
    - View Videos
    - Download Videos
    - Access Quiz
        - Print Certificate
        - View Quiz Score

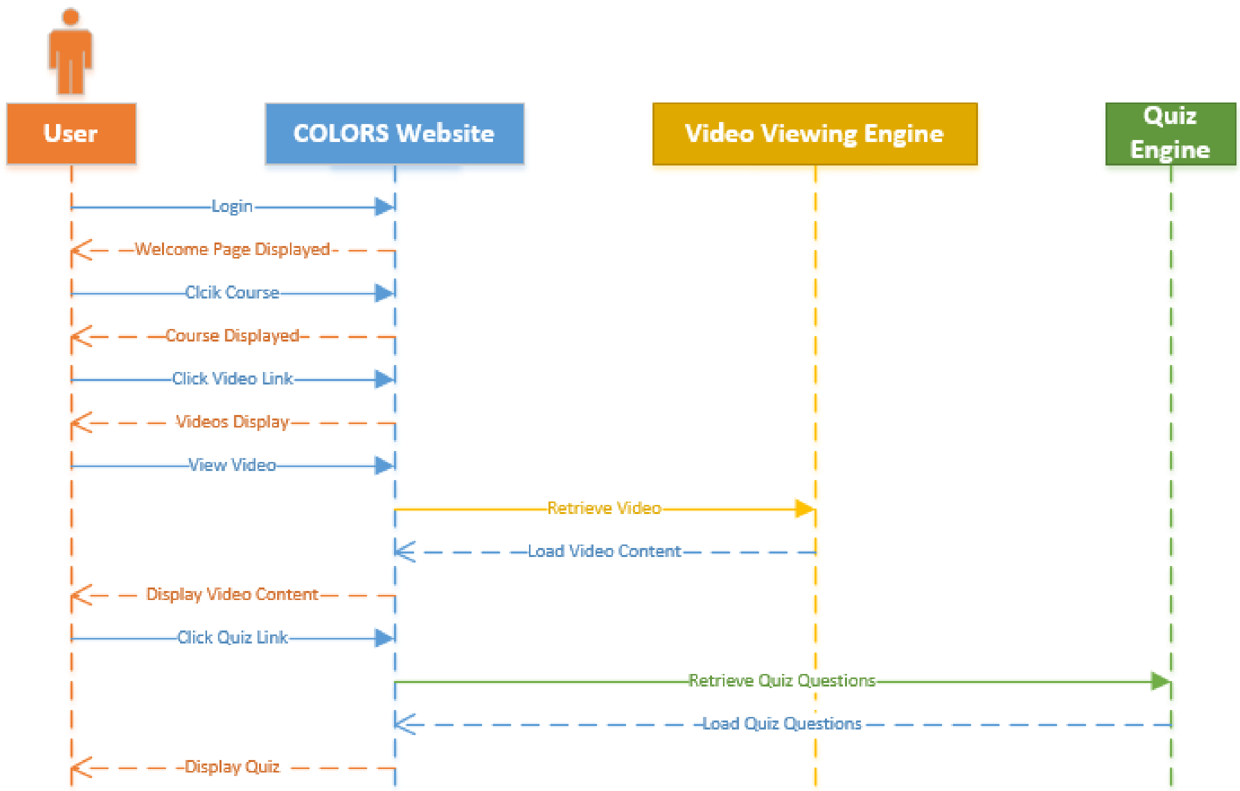


Figure 6-6: Sequence Diagram for COLORS Application

The sequence diagram shown in Figure 6-6 shows how the student users interact with the website interface. The interface interacts with a Video Engine as well as a Quiz Engine. These two engines are third-party tools within the COLORS application.

From the wireframe in Figure 6-7, you will see that name, e-mail and password are the only information that is collected up front in order to allow the user to register for the COLORS application. This leads to a key user design guideline which is a simple registration screen if one is required. One of the goals may be to allow the user to use their social media account to log in as oppose to setting up a new username and password. Simplified registration is key because the researcher want students to be able to register and remember their log in information.

Once a user is registered for the application, they can login to the application. The username is just their e-mail address and was done this way in order to provide a simple way they can remember this information. If a user is able to log in, they will be presented with the welcome page where they can view course they are enrolled in at that time. They also can view courses within the course catalog or access a course within which they are registered. Figures 6-7 through Figure 6-11 shows the wireframes for the COLORS application and the page layouts. The low fidelity prototypes allowed us to focus on the conceptual design phase and explore some alternatives in the design of the system. In Figure 6-7, you will see a prototype of the homepage. From the home page, the user can sign into the application or register. If the register option is clicked, the user must enter some basic information for the system to create an account. If the username/password combination is entered, the user can select "Log-In". Once inside the application, a listing of courses will appear based upon user information. Figure 6-8 is similar to this figure; however, it shows the admin process.

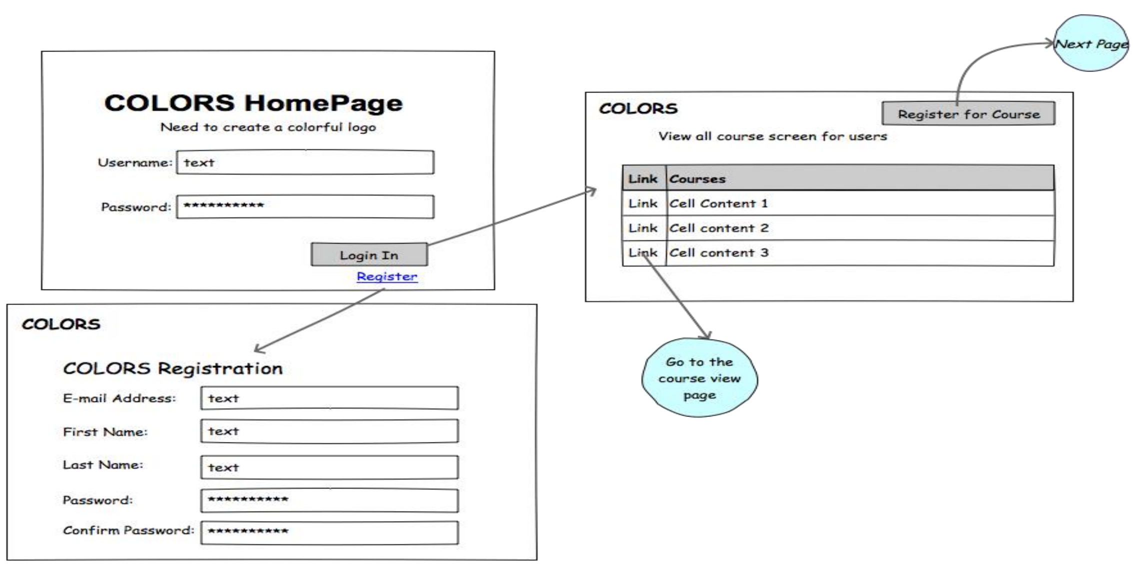


Figure 6-7: Home Screen & Registration wireframe

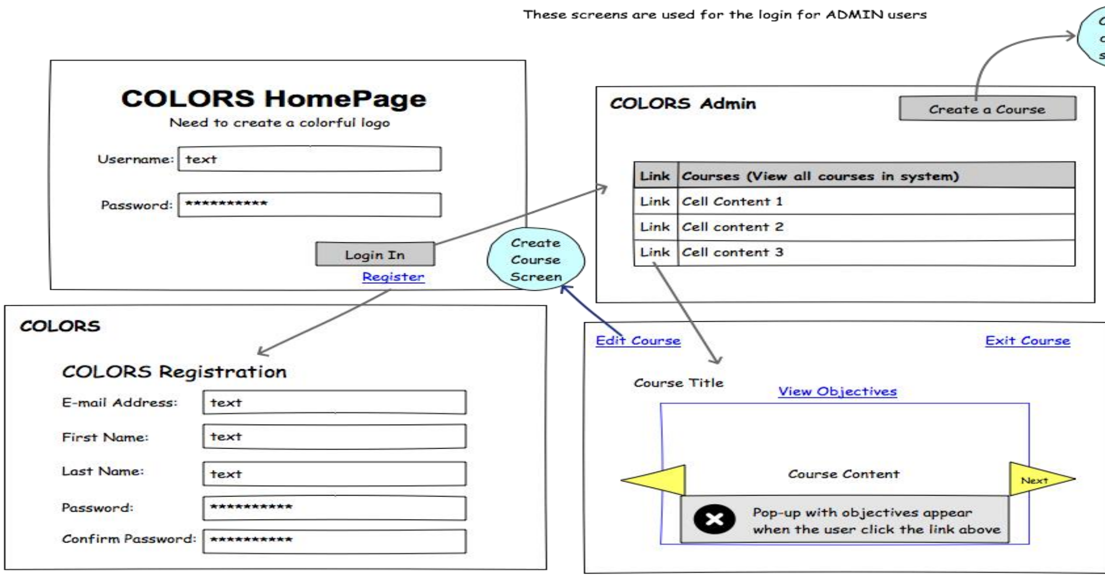


Figure 6-8: Admin Course Entry/Course View

In Figure 6-9, the navigation through the COLORS application is shown. Based upon the prototypes, users will be able to view a listing of lessons and select individual lessons to view. Each lesson will assess what the user learned through a quiz. Within the lesson the user will be able to navigate to the associated quiz. These prototypes allowed us to ensure that a 2016 web-based designed principles were being used in order to ensure a cohesive and updated design.

Information for courses needed to be inputted into the system by an administrator user. In Figure 6-9, you will see the functionality and flow of how administrator users can add courses and content to courses. The interface layout shown in figure 6-11 shows how the user can register for the courses that are added by administrators (admins).

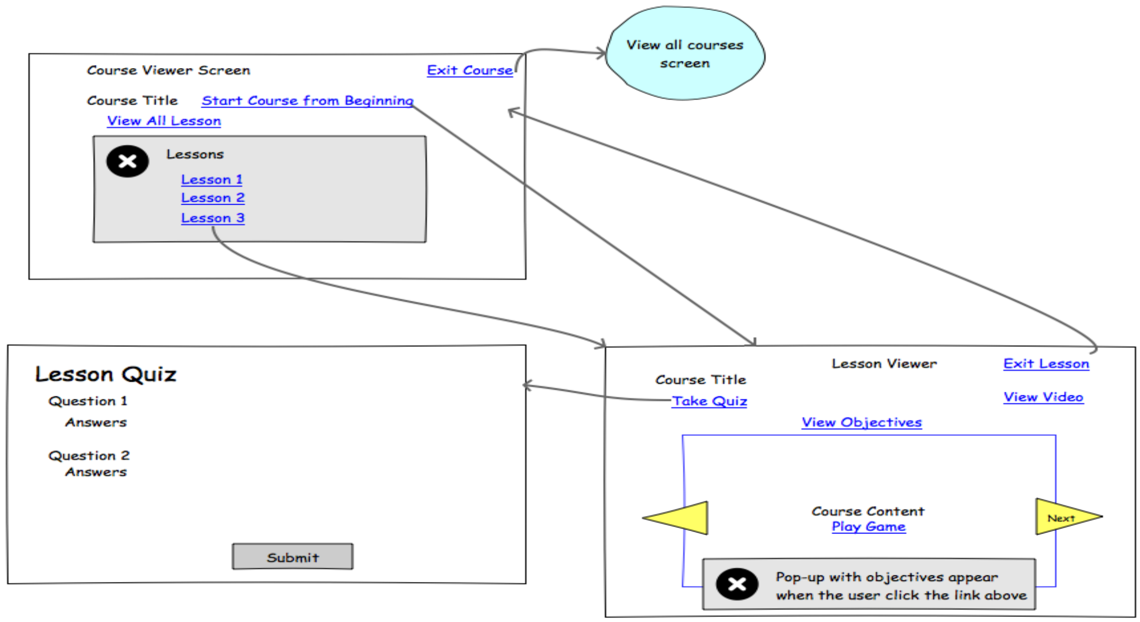


Figure 6-9: User Navigation/Course View

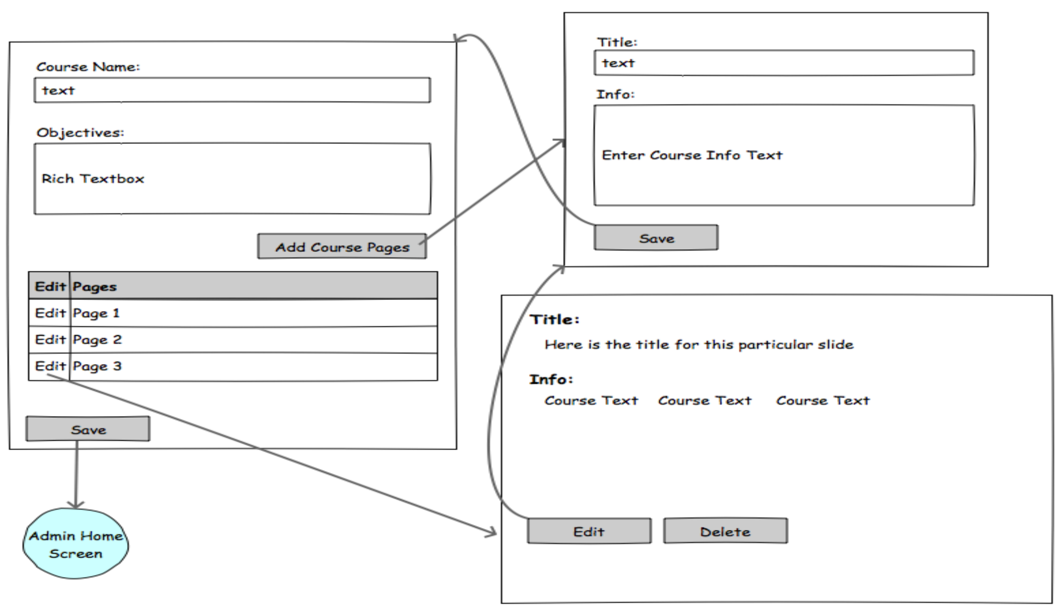


Figure 6-10: Admin Course Setup View

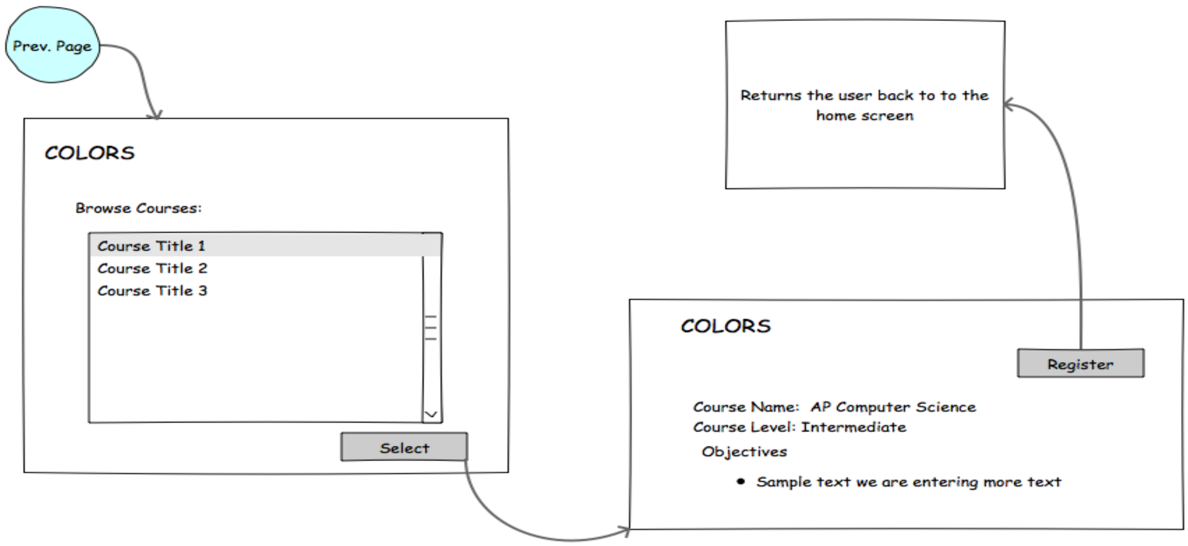


Figure 6-11: Course Selection

6.3 Final COLORS Application

The primary focus of this study was to explore web-based learning environments to support informal learning and develop a set of design guidelines for these systems. In the next several figures, you will send screenshots from the final COLORS application. In Figure 6-12, you will see the large hero image in the background with a very long scroll. The user can log into the application or read additional details about the application.

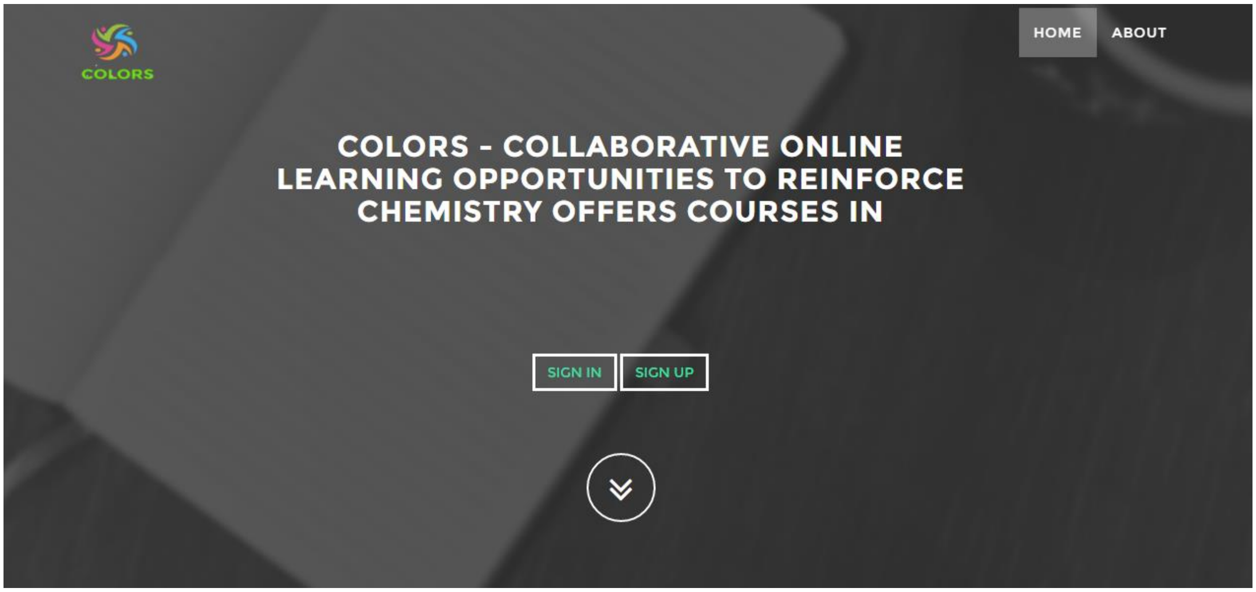


Figure 6-12: COLORS Home Screen

Once a user is authenticated, a home screen will load containing a listing of courses. Across the top, you will see the COLORS logo on the left side of the screen and the main navigation on the right. The links for each of the courses are clickable and will navigate the user into the course in order to view videos, lessons and quizzes.

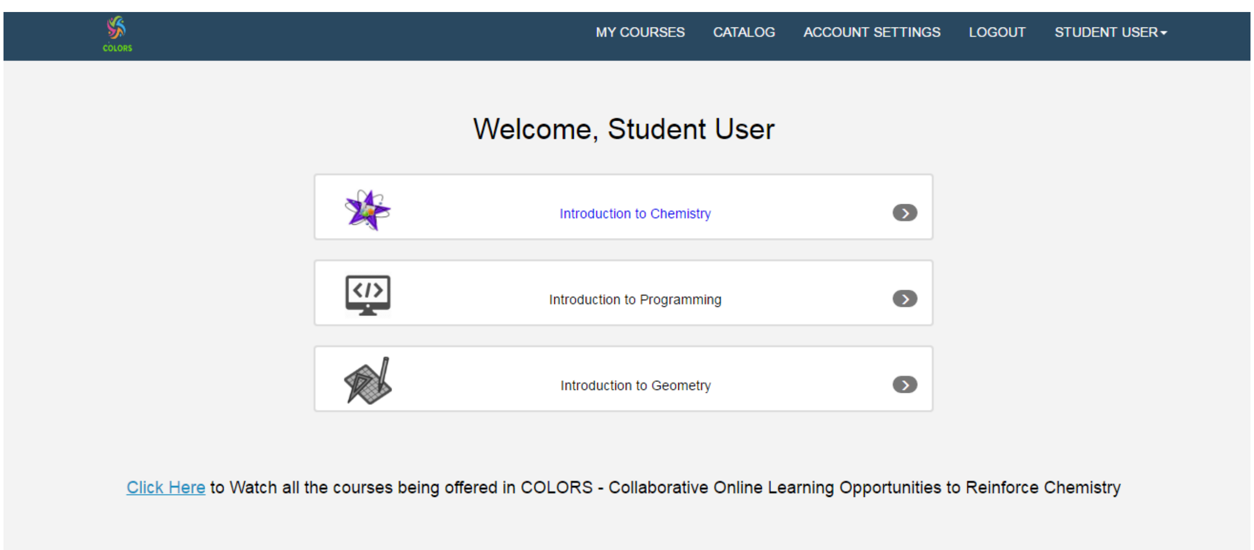


Figure 6-13: COLORS Welcome Screen

In Figure 6-14, you will see the interface of the course view. The course view contains three sections. The first section as shown in Figure 6-14, shows the video area. This area contains any relevant videos. The videos can be separated by topic or lesson.

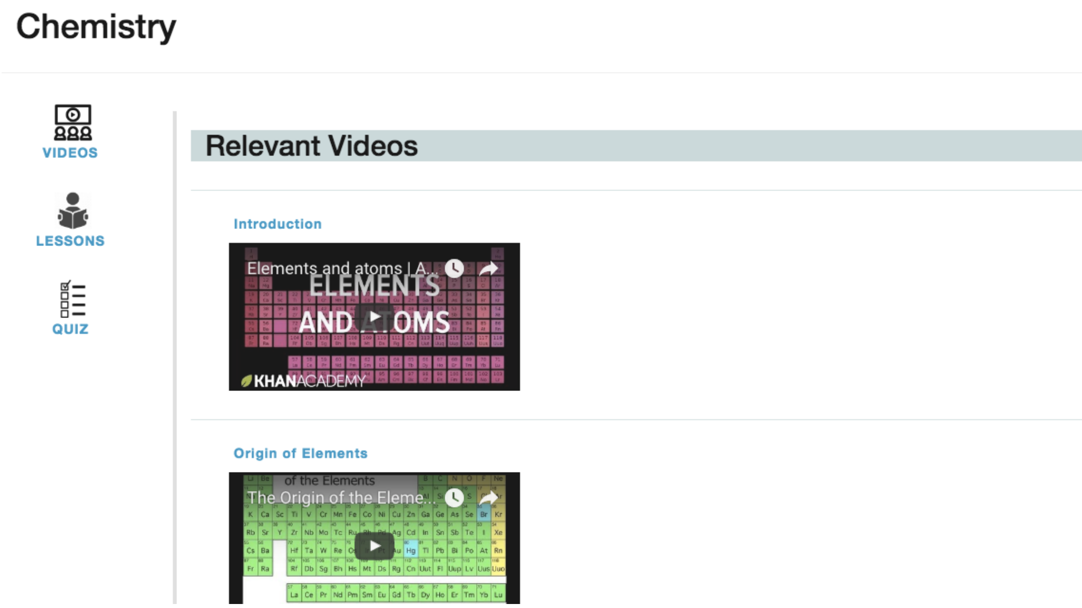


Figure 6-14: Course View: Videos

The next area shown in Figure 6-15, is the Lessons section. As with videos, lessons can be arranged in different topics. Lessons can be viewed directly on the screen requiring no download. This is beneficial because if a student is using a public computer they are normally restricted from downloading any files. The final screen shot of the course view show the quiz section. See Figure 6-16. This section can contain one or more quizzes pertaining to the course content. The quizzes can be created with a variety of question types such as short text and multiple choice. Since the environment is targeted toward informal learning, for short answer questions the answer is given to the student to access their understanding once a quiz is submitted and the results are returned.

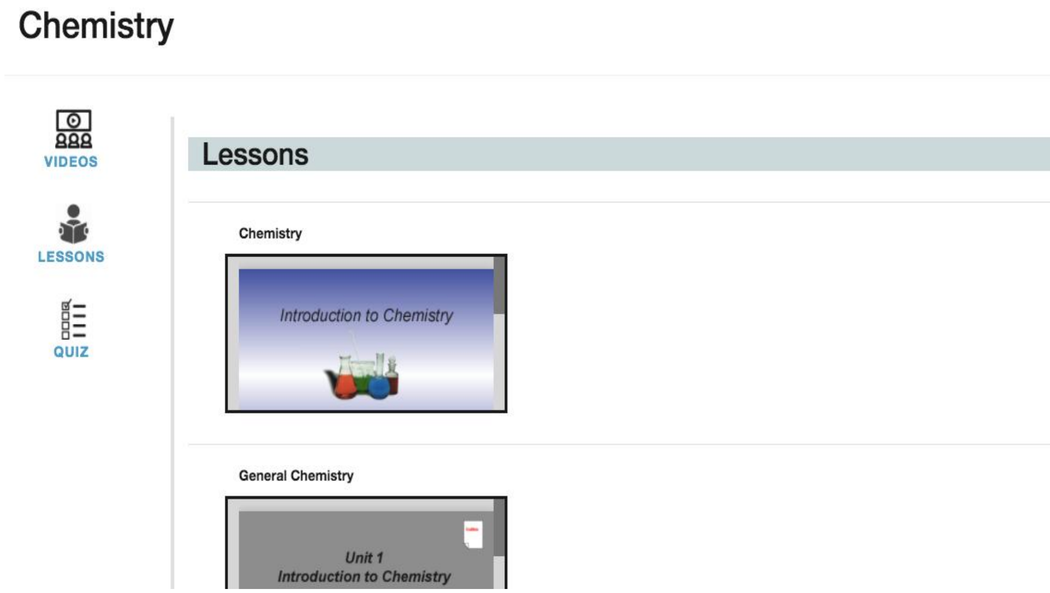


Figure 6-15: Course View: Lessons

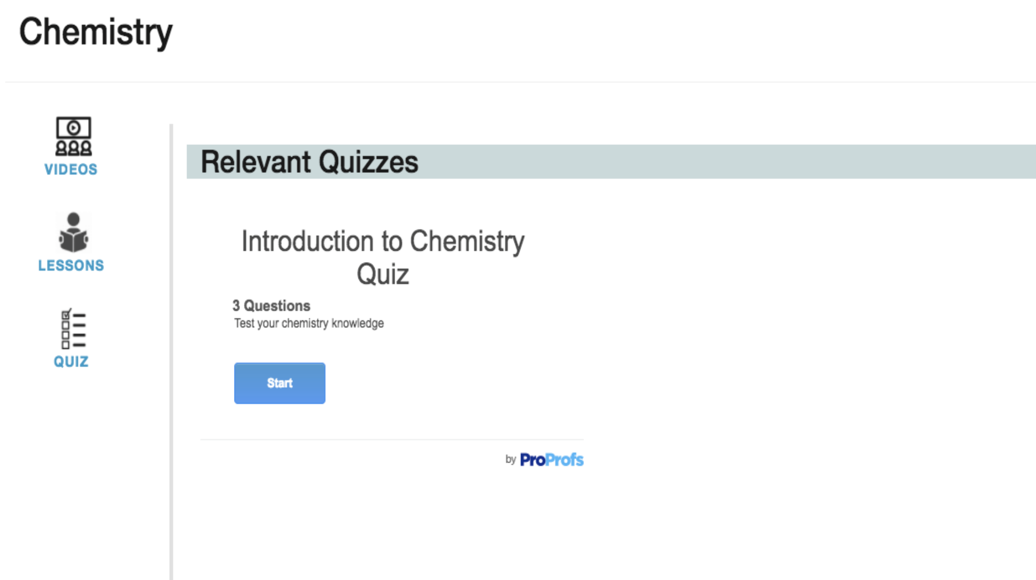


Figure 6-16: Course View: Quizzes

CHAPTER 7: COLORS ANALYSIS AND EVALUATION

The primary focus of this study was to explore web-based learning environments that would support informal learning and how these environments can increase course access amongst K–12 students to enhance the overall learning experience. One particular way web-based learning environments can support informal learning is through making content from teachers around the world available to students around the world. Another way web-based environments can support informal learning is through the offering of multiple classes that students may not have access to within a traditional classroom setting. This study identified the local Upward Bound program members as the initial subgroup that will benefit from the results of this research. The main criterion for choosing members to participate in the study is a voluntary acceptance of high school students to willing register and login to use the COLORS website that was developed to potentially increase the availability of course offering among low-income communicates by using web-based environments that support informal learning. There are many characteristics and attributes that make up the usability of a system. Participants will provide feedback on the learnability, user satisfaction, effectiveness for achieving tasks, operability and accessibility (Hasan & Al-Sarayreh, 2015). Ultimately, demonstrating how easy the application is to use by novice users for supporting informal learning amongst high school students. The COLORS application is assumed to be a framework model for collecting quantitative data on using informal web-based learning environments to increase access to a variety of STEM courses. To extend this study, the researcher focused on the development of a set of web-based design guidelines that support the implementation of informal web-based learning environments.

This sections presents a comprehensive evaluation of the COLORS application that was used by high school students. As outlined in the subsequent sections, the comprehensive evaluation will rely on analytic and empirical evaluations conducted by experts on potentials users. This section also includes the general methodological concerns for the empirical study conducted and the comparative evaluation. This section presents the results from an expert evaluation done on the COLORS application comparing it against acceptable usability principles which allowed us to clearly identify user design guidelines.

The usability of the systems was evaluated based upon ease of use. This is important because if system is not design with appropriate usability there is a possibility of system failure due to low usage (Qadoumi & Al-Shurufat, 2015). One of the goals of this research was to look at web usability issues within web-based environments to support informal learning. The experts and empirical evaluations will explain the Experimental Design, Data Collection and Experimental results. The data collection section will present method for the work, materials uses, experimental data (i.e. demographics, user satisfaction questionnaires), procedures and experimental observations. This section concludes with a discussion of the experimental hypothesis and the implications of the study. The usability results and implications support the adoption of COLORS application as a suitable tool for informal learning. These results and implications will be used to support our framework for informal web-based learning environments.

7.1 Overview

The experimental procedure included a pre-questionnaire, a task list, and post-questionnaire to collect data from the experts during this phase of the study. Twenty participants were surveyed during the pre-questionnaire phase. The participants ranged from 13–17 years of age.

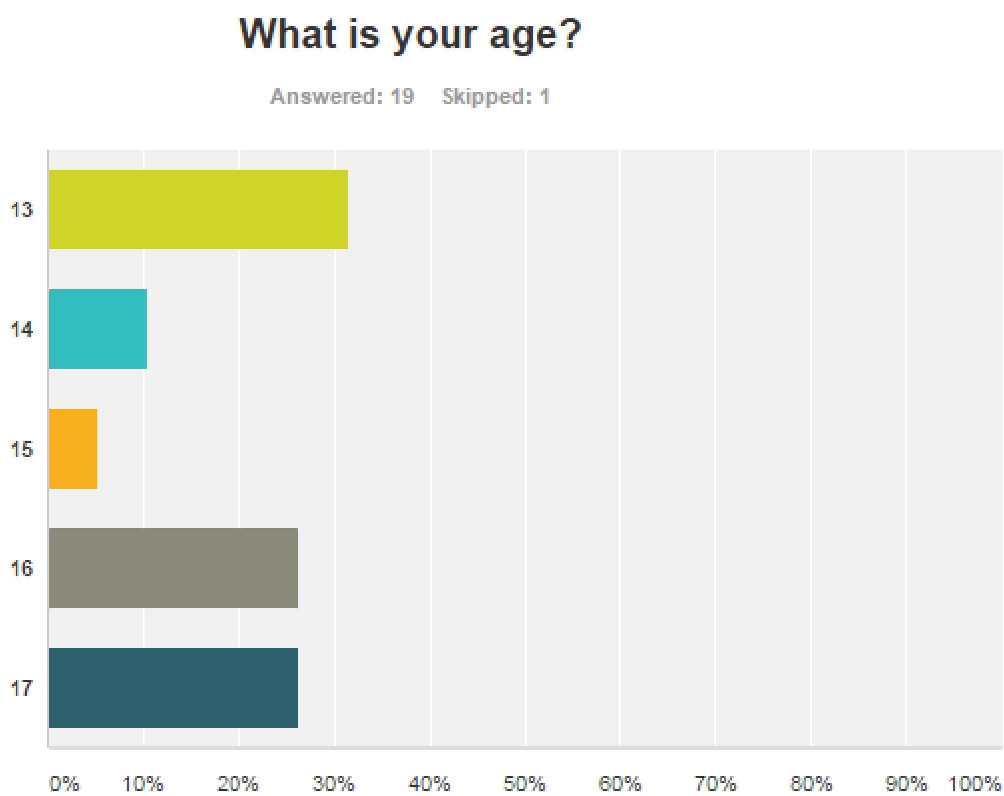


Figure 7-1: Pre-Questionnaire Participants

Seventeen participants participated in the post-questionnaire. Based upon the participation ID, 85% of the users who completed the pre-questionnaire also completed the post-questionnaire. The main purpose of the study was to gain insight on the effectiveness of the COLORS application. The research approach included creating an environment where students ages 13–17 could access various courses in support of informal learning. Thus, the four main goals of the study were to:

1) Enhance technical skills of novice users as well as introduce new technical skills to novice users
2) Encourage users to adopt the use of technology for informal learning instead of traditional teaching methods
3) Provide a flexibility and personalized learning experience to user
4) Suggest a set of user design guidelines that will strictly focus on the development of learning environments for the K–12 audience, specifically users ages 13–17
5) Conduct a usability and acceptance test with the test group
6) Conduct a usability expert evaluation
7) Increase the availability of STEM related courses within low income communities

To gather more data on the usability and effectiveness of the web-based learning environment, experimental participants performed a series of tasks to include completing a detailed survey to provide feedback on their experiences with the system. The immediate contributions this research will increase the availability/exposure of course options within low income communities. In addition, the results of this research may capture and generate interests within the computer-supported collaborative learning community.

This work supports our hypothesis among potential user groups. Our goal was to answer the following questions:

1) With what aspects of informal learning would individuals in low-income areas like to see offered that they don't have access to now and what type of considerations need to be made when providing these types of courses?

2) What types of factors (usability and security) need to be engaged in order to provide a usable and secure environment for the K–12 audience?
    a. Are there any key usability issues that face K–12 students when trying to learn within an informal learning environment (Jacob Nielsen Guidelines)?
    b. Is there any key security concerns for student accessing course information in a web-based environment?
3) In what ways do providing informal learning courses affect how students feel about the quality of education they are receiving?
    a. Based on the course they participated in, do they feel an increase understanding in the subject area and/or felt it was valuable information?
4) Do students feel that they can and are improving their knowledge in various subjects offered by completing courses within the informal learning environment?

In order to address the questions, the researcher completed a comparative evaluation using the created environments and supporting principles. In the comparative study evaluation, the researcher presents methods for the work, materials used, experimental data (i.e. demographics, user satisfaction questionnaires), procedures experimental metrics (i.e. artifacts, etc.) and experimental observations. The comparative study concluded with a final comparison evaluation in the form of an expert user interface evaluations of artifacts created during the study.

7.2 Experimental Design

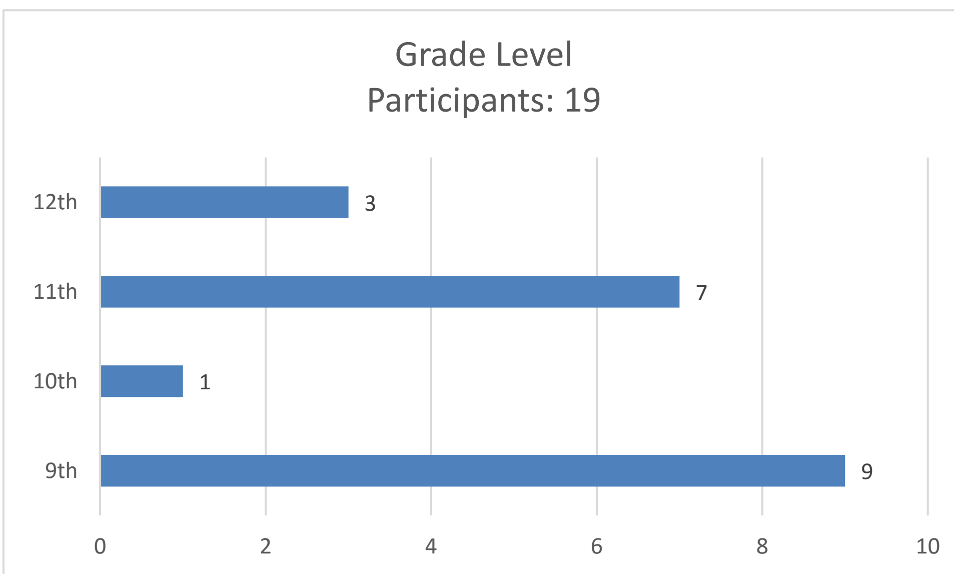
The experimental design for the comparative evaluation included two within-subjects factor (ChemiNet vs. COLORS). The first evaluation was done with students ages 13–17 users. The breakdown of the participants can be seen in Figure 6-2. For this study, an outline of participants, material and an overview of experimental results will be discussed.

7.2.1 Student Comparative Evaluation

The following results were identified from teenagers ages 13–17 in the Southern region of the United States. This section will outline the participants, materials and statistical results.

Participants

The participants in the study were teenagers between the ages of 13–17 in the Southern region of the United States. Based upon the results shown in Figure 6-2, 20 participants were administered the pre-questionnaire and 19 completed the questionnaire. Three (3) students reported they were in 12th grade. Seven (7) students reported they were in 11th grade. One (1) student reported they were in 10th grade. Nine (9) students reported that they were in 9th grade. All participants were in twelfth, eleventh, tenth or ninth grade. Of the nineteen participants,



there were (9) females and (10) males.

Figure 7-2: Demographics: Grade Level

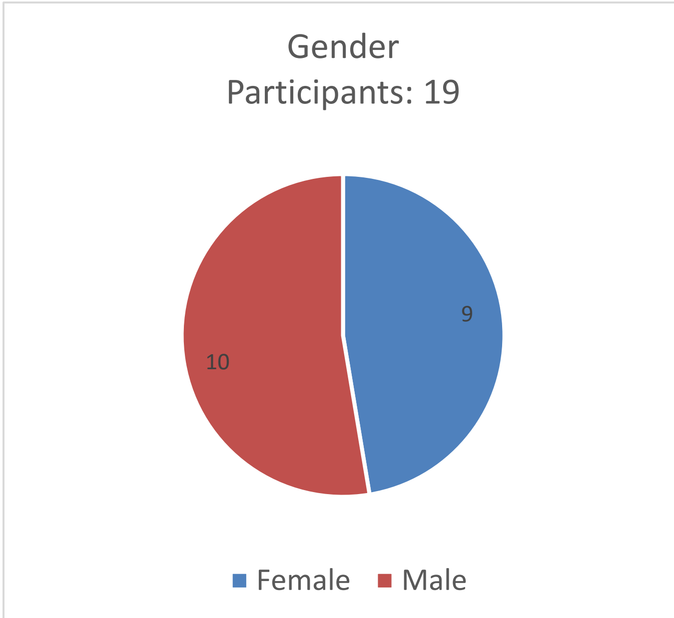


Figure 7-3: Demographics: Gender

Materials

The materials for the experiment included the informed consent for users to sign before undertaking the experiment and a list of tasks that were prepared to guide the participant through the two systems. Also, each student was given a pre-questionnaire and a post questionnaire.

Informed Consent – The Auburn University Institutional Review Board requires researchers to have an informed consent approval of research designs when conducting any type of research involving human subjects. The informed consent stated to the participants the purpose of the study, justification, procedures, benefits, and risks of the project. It also informed the participants that all information collected will be held confidential. Lastly, it informed them that the study was strictly voluntarily and there were no requirements to participate.

Pre-Questionnaire – The pre-questionnaire shown in Appendix H allowed us to capture the demographics of the participant group. The instrument used in this study consisted of two

(2) parts containing a total of twenty-seven (27) questions. The first part of the pre-questionnaire gathered background and demographics information. The second part of the pre-questionnaire gathered the participant competences information in using web technologies such as e-mail, web development, discussion databases, etc.

Task list – The task list was used to guide participants through the two applications; COLORS and ChemiNet. The task list contained the specific tasks that each participant was to complete. It also outlined how the user should generate the participation ID in order to keep surveys anonymous.

Post-Questionnaire – The post-questionnaire found in Appendix I was used for gathering detailed information about how participants assessed the usability of the system. The post-questionnaire consisted of 29 Likert-type scale items for each system. The Likert-type scale items were assigned a value to each response. The responses were (5) Strongly Agree, (4), Agree, (3) neutral, (2) Disagree, (1) Strongly Disagree. There are additional questions using a slightly different Likert-type scale of (5) Very High, (4) High, (3) Moderate, (2) Low, (1) Very Low.

Table 7-1:

Guidelines for User Rating of COLORS/ChemiNet System (2 Tables)

RATINGS	ACTION REPRESENTATION	
5	Strongly Agree	A rating of Strongly Agree indicates that the applications models the given criteria with a high level of aesthetic appearance/functionality.
4	Agree	A rating of Agree indicates the application models the given criteria with a fairly high level of aesthetic appearance/functionality.
3	Neutral	A rating of Neutral indicates the application models the given criteria with good aesthetic appearance/functionality.
2	Disagree	A rating of Disagree indicates the application models the given criteria with some level of aesthetic appearance/functionality.
1	Strongly Disagree	A rating of Strongly Disagree indicates the applications models none of the given criteria.

RATINGS	ACTION REPRESENTATION	
5	Very High	A rating of Very High indicates that the applications models the given criteria with a high level of flexibility, interactability, learnability and visual appearance.
4	High	A rating of High indicates the application models the given criteria with a fairly high level of flexibility, interactability, learnability and visual appearance.
3	Moderate	A rating of Moderate indicates the application models the given criteria with good flexibility, interactability, learnability and visual appearance.
2	Low	A rating of Low indicates the application models the given criteria with some level of flexibility, interactability, learnability and visual appearance.
1	Very Low	A rating of Very Low indicates the applications models none of the given criteria.

Experiment Setup and Requirements

The study was conducted amongst high school students within Alabama. The same group completed the pre-questionnaire and post questionnaire.

Procedures

An informal session was conducted amongst high school students ages 13–17. Dates were provided for the evaluation. Emails were sent to participants that contained the Auburn University Institutional Review Board's approval for the experiment and affirms the informed consent. This was to familiarize them with what was expected, the time commitment and allow them the opportunity to have the parents of the participants sign the informed consent to allow participation or decline to participate.

Each participant was given a task list that outlined the tasked to be completed. The first task was for the participant to come up with a unique participation ID and write it down. During the study, participants completed a printed or online pre-questionnaire. This pre-questionnaire was used a baseline in order to gauge the participants background and demographic information. It also determined whether the participants met the minimum qualifications or set standard as a user regarded as suitable for the experiment. The next set of tasks involved the users completing a set of actions within both the ChemiNet and COLORS applications. Once completed, each user completed a post-questionnaire.

All potential participants were informed that the data from the survey were being used for a dissertation. An assurance of anonymity was given to all participants. No identifying information was recorded in the system concerning a participant. All procedures for the protection of human subjects were reviewed by Auburn University Institutional Review Board (IRB) and approved for use in this study. The IRB is shown in Appendix C.

Data Collection and Analysis

All data for the research study was collected using the following instruments: Pre-Questionnaire and Post-Questionnaire. Both instruments have been described above.

Table 7-2:

Experimental Instruments and Measures

INSTRUMENT	DESCRIPTION
Pre-Questionnaire	K–12 Student User background, demographics, expectations, etc.
Post-Questionnaire	User satisfaction and system ratings

Experimental Results

The goal of the empirical study was to do a comparison study to assess user reaction of the two systems based purely on their observation of the systems while completing a pre-determined set of tasks.

Pre-Questionnaire Results

The participants in the study were majority African Americans (94.74%) in grades 9–12 from various high schools within Alabama. The remaining participant(s) reported as Other. One participant skipped this question. This information is outlined in Figure 7.4.

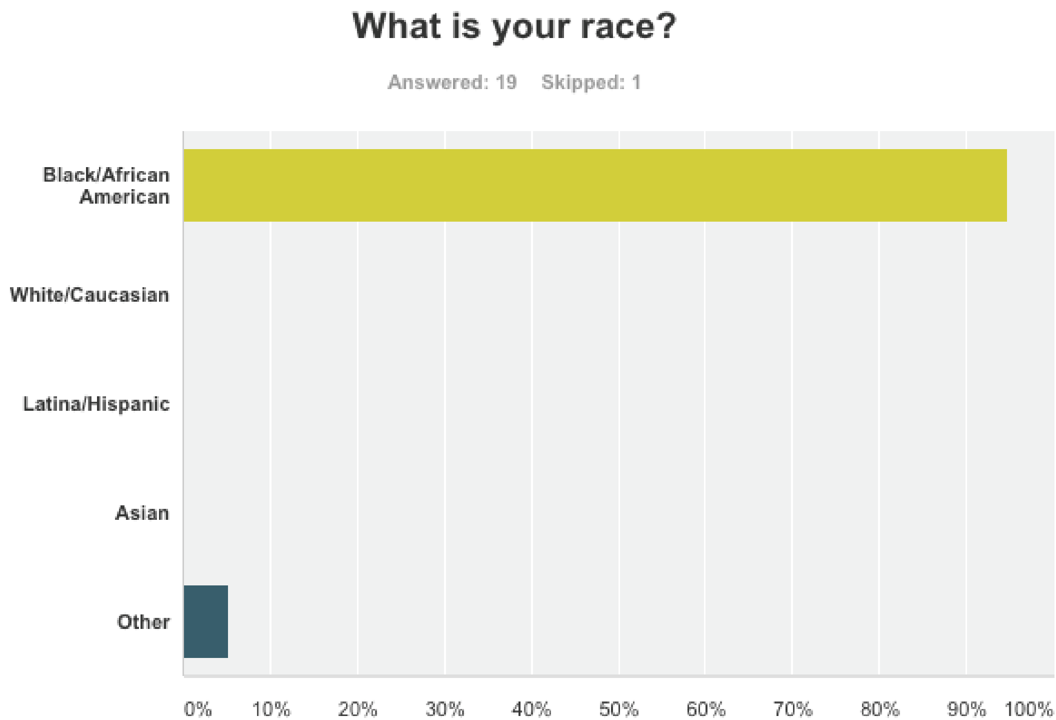


Figure 7-4: Demographics: Race

A majority (78.95%) of the participants indicated that they used a computer to do homework while 57.89% used the computer for email. The next highest was surfing the net at 47.47% then followed by Social Media and Playing games which are both at 36.84%. Blogging was last at 21.05%. This information is outlined in Figure 7.5.

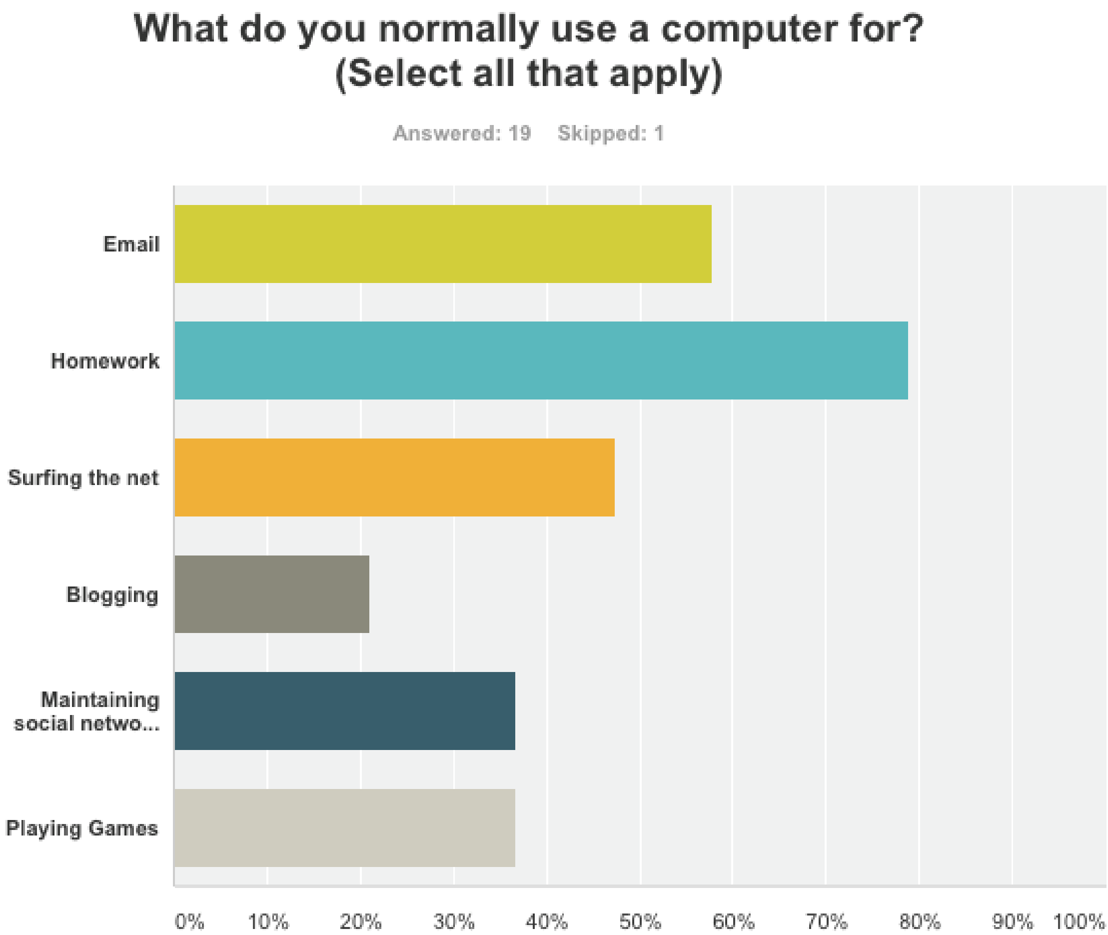


Figure 7-5: Demographics: Normal Computer Use

Most (94.74%) of the participants as shown in Figure 7.6 used the computer at school while 89.47% use the computer at home. A small percentage selected Other (5.26%).

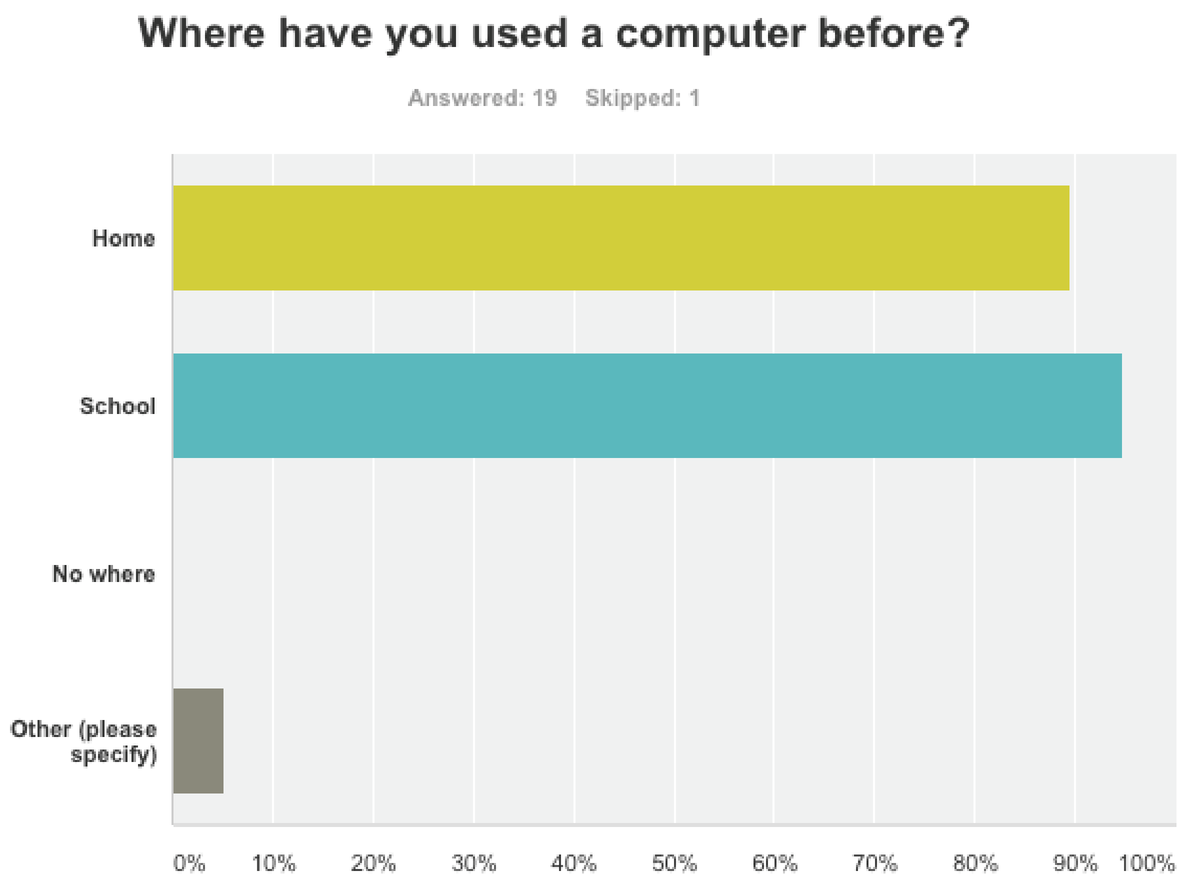


Figure 7-6: Demographics: Location of Computer Use

In Figure 7-7, a majority of the participants (94.44%) felt that online material can enhance traditional classroom learning, while 5.56% reported no prior experience using an online learning environment.

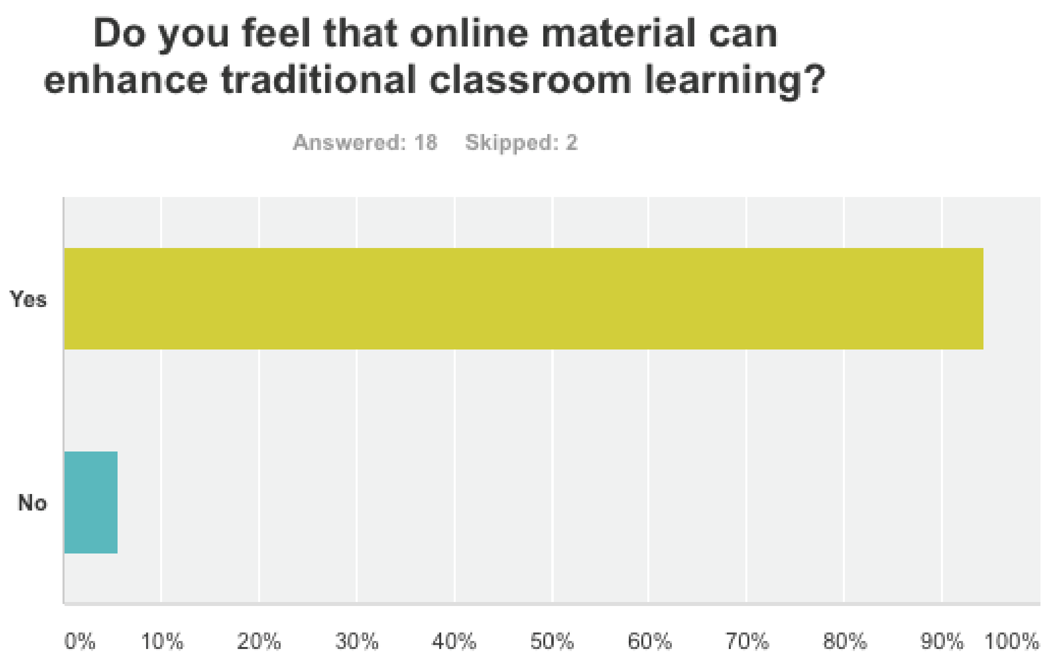


Figure 7-7: Demographics: Online Material Enhance Classroom Learning

From the results (Figure 7-8), majority of the participants (over 78%) stated they use a computer for school work more than an hour a day. With respect to the hypothesis (HA_2) on user satisfaction compared to traditional learning, on prediction was *there will be a significant user satisfaction with the implemented web-based learning environment versus traditional methods of collaboration and informal learning options for K–12 students in low income communities.* Based upon the information presented from the student users, the researcher saw that majority of participants felt online material can enhance traditional classroom learning.

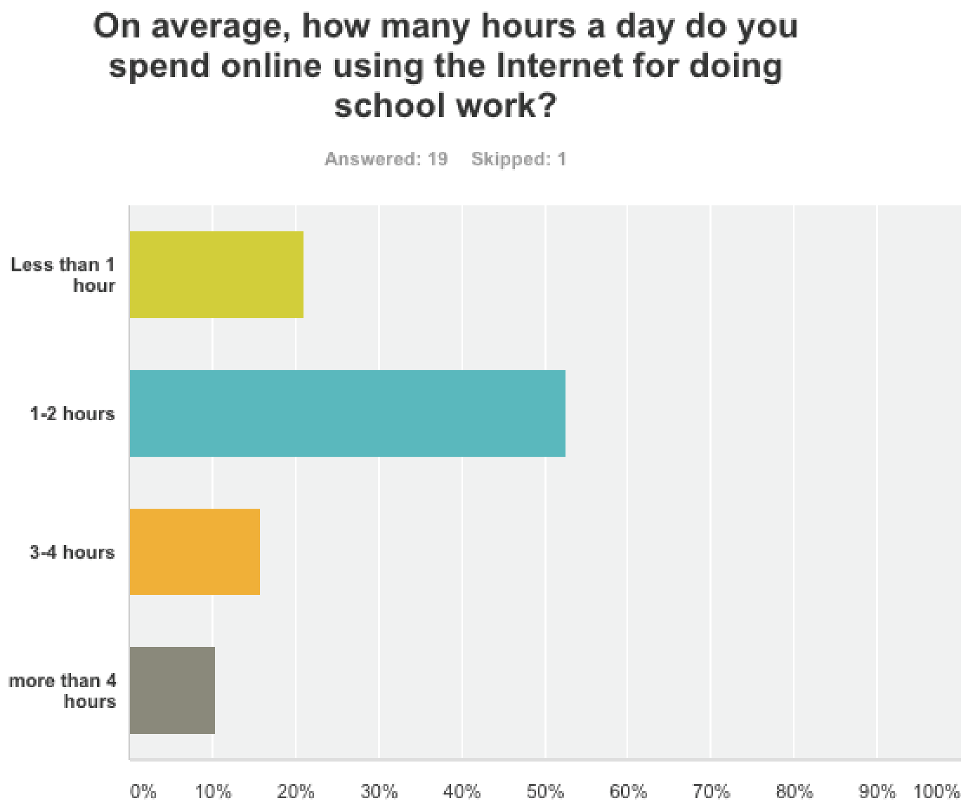


Figure 7-8: Demographics: Hours Spent Online for School Work

Over half of the participants (57.89%) had prior experience taken courses within an online environment. This information can be seen in Figure 7-9.

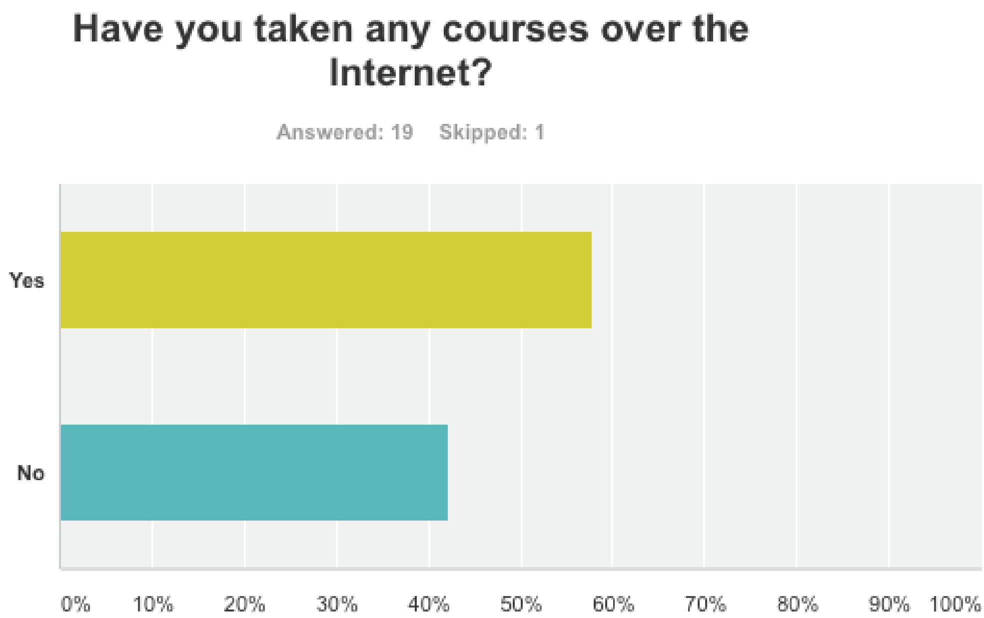


Figure 7-9: Demographics: Taken Course over the Internet

Post-Questionnaire

Based upon the post-questionnaire, the researcher was able to conduct an evaluation of the two application. The results from each of the applications were compared. Only 89% of the students from the pre-questionnaire participated in the post-questionnaire due to students not being obligated to return for the experiment and post-questionnaire. In Table 7-3, you will see a small subset of the results from the post-questionnaire. Based upon the results displayed, COLORS applications was favored by students over the ChemiNet application.

Table 7-3

Post-Questionnaire (COLORS vs ChemiNet)

Overall Reaction to the applications (COLORS vs ChemiNet)	COLORS	ChemiNet
Learnability	4.56	4.54
Visual look of System	4.22	4
Interactive feel of the System	4.33	4
Playability(Easy to Play	4.00	3.85
Interesting	4.11	4.08
The graphics are very appropriate for this site	4.33	3.92
The amount of information displayed is just right	4.55	4.46
The colors in this website are pleasant	4.55	4
It is wonderful	4.00	3.62
The site organized its information in a way that is easy for me to understand	4.44	4.38
This site's attractiveness invites me to go further into this site.	4.78	4.38

Based on the results, 100% of the participants said they would recommend the COLORS applications vs approximately 76% would recommend to the ChemiNet application. A majority of all participants (88%) felt the COLORS application was fun and pleasant. All results from the post-questionnaire can be viewed in Appendix I.

This evaluation allowed us to addressed Hypotheses listed under User Satisfaction/ Learning (HA_1). With respect to the specific hypotheses related to User Satisfaction, one prediction was that *there will be significant difference between the usability and learnability of the control and experimental environments in terms of user ratings of overall satisfaction ease of* *use, and motivation.* From the results shown above, COLORS average was greater than ChemiNet in all areas.

There are two additional hypotheses listed under User Satisfaction/Learning. With respect to the specific hypothesis (HA_2) related to User Satisfaction, one prediction was that *there will be a significant user satisfaction with the implemented web-based learning environment versus traditional methods of collaboration and informal learning options for K–12 students in low income communities.* Based upon survey results, 100% of the participants said they would recommend the COLORS application.

The last hypothesis (HA_3) listed under User Satisfaction/Learning is *there will be a significant increase in the morale among K–12 students' satisfaction with ease of use of the implemented web-based learning environment versus traditional collaboration tools e.g. BB based tool.* Based upon observation of student using the application and results of the survey, all participants felt COLORS was easy to use.

7.2.2 Expert Comparative Evaluation

As a final evaluation metric, the researcher recruited several experts to judge the usability and quality of the COLORS and ChemiNet applications. The expertise of these judges was based on their highest degree in computer science, experience in the HCI field, experience in software engineering or design, and experience in usability engineering, user interface design, interface evaluation or computer supported collaborate learning. The following results were identified from Usability Experts at Auburn University. This section will outline the participants, material and statistical results.

Participants

The participants in the study were graduate students at Auburn University in the Department of Computer Science and Software Engineering in Auburn, Alabama. Based upon the results, the researcher brought in 12 experts evaluate the ChemiNet application and 9 experts evaluate the COLORS application based upon the results captured using the SurveyMonkey tool. All participants have a background in usability and user evaluations.

Materials

The materials for the experiment included the informed consent for users to sign before undertaking the experiment and an informational including the information on how to access the COLORS and ChemiNet sites and the evaluations for both sites.

Informed Consent – The Auburn University Institutional Review Board requires researchers to have an informed consent approval of research designs when conducting any type of research involving human subjects. The informed consent stated to the participants the purpose of the study, justification, procedures, benefits, and risks of the project. It also informed the participants that all identifying information collected, if any, will be held confidential. Lastly, it informed them that the study was strictly voluntarily and there were no requirements to participate.

Table 7-4

Experimental Instruments and Measures

INSTRUMENT	DESCRIPTION
Expert Evaluation - ChemiNet	UI experts' ratings of ChemiNet web-based learning environment.
Expert Evaluation - COLORS	UI experts' rating of COLORS web-based learning environment.

Expert Evaluation (ChemiNet) – The expert evaluation shown in Appendix J allowed us to captures the results of the participant group. The instrument used in this consisted of 43 questions concerning design techniques. The questions are answered on a Likert Scale ranging between 1 and 5. All results from the survey were captured using Survey Monkey Tool.

Expert Evaluation (COLORS) – The expert evaluation shown in Appendix K allowed us to captures the results of the participant group. The instrument used in this consisted of 43 questions concerning design techniques. The questions are answered on a Likert Scale ranging between 1 and 5. All results from the survey were captured using Survey Monkey Tool.

Table 7-5

Guidelines for Expert Rating of COLORS/ChemiNet System

RATINGS	ACTION REPRESENTATION	
5	Excellent	A rating of Excellent indicates that the applications models the given criteria with a high level of usability.
4	Above Average	A rating of Above Average indicates the application models the given criteria with a fairly high level of usability.
3	Average	A rating of Average indicates the application models the given criteria with good usability.
2	Below Average	A rating of Below Average indicates the application models the given criteria with some level of usability.
1	Poor	A rating of Poor indicates the applications models none of the given criteria.

Experiment Setup and Requirements

The study was conducted amongst experts within the Computer Science and Software Engineering graduate school. One group completed the evaluation of COLORS and another group completed the evaluation of ChemiNet.

Procedures

The informal sessions were conducted amongst graduate students in the Auburn University Computer Science and Software Engineering department. Each participant was informed that this experiment was completely voluntarily and were provided with consent letter. Each participant who consented to the study was given a URL to the application they were selected to review. Selection was done based upon if the last digit in AU banner ID was old or even. Students simply acknowledge if their number was even or odd. During the informal session, experts were also given the URL to an expert evaluation. After reviewing the application, each expert completed the expert evaluation. All usability testing took place over the Internet in order to accommodate a large number of participation.

All potential participants were informed that the data from the survey were being used for a dissertation. An assurance of anonymity was given to all participants. No identifying information was recorded in the system concerning a participant. All procedures of human subjects were reviewed by Auburn University Institutional Review Board and approved for use in the study. The IRB is shown is Appendix C.

Our experts were given information about the intent and rationale for the evaluation, namely to ascertain the perceived quality of the web-based learning environments. The researcher also informed them that the web-based learning applications were addressing topics relevant to high school STEM courses specifically Chemistry. The web-based applications to be evaluated were ChemiNet and COLORS.

Data Collection and Analysis

All data for the research study was collected using the following instruments: ChemiNet Expert Evaluation and COLORS Expert Evaluation. This information can be seen in Table 7-4.

Experimental Results

The goal of the research study was to do a comparison study to assess user reaction of the two systems. This study evaluated the strengths and weaknesses of the two systems based upon research, deep knowledge in the area of HCI, industry experience and best practices. From this comparison, quantitative data was gathered in order to gauge how well the new web-based learning environment measured up to the web-based learning environment developed within the preliminary study. In the next two sections, the results from the ChemiNet Evaluation and COLORS Evaluation will be shown.

ChemiNet/COLORS Comparison Evaluation

The participants in this study were considered experts with a deep knowledge in the area of HCI and web-based learning environments. Out of the thirty-six (36) comparative measures each of the system was evaluated based upon, seventeen (17) will be reviewed in this section. All results can be seen in the Appendix N. With respect to the specific hypotheses related to usability (HB_2), one prediction was that *there will be a significant difference between the preliminary web-based environment (ChemiNet) and the implemented web-based learning environment interface (COLORS) based on the usability experts' evaluations*. Quantitative evidence related to this hypothesis can be found in the results from the expert evaluation of ChemiNet and COLORS. A snapshot of the results is shown in Figure 7-10. Although the results were not significant, the researcher did find that COLORS is more favorable than ChemiNet.

With respect to the specific hypotheses related to usability (HB_3), one prediction was that *there will be a significant improvement in expert's ratings on visual quality and organization of information on the implemented web-based learning environment tool versus traditional methods*. The expert empirical evaluation showed that the visual quality of the COLORS application was above average. The COLORS application used the latest web design techniques and features in order to convey information to students and facilitate the learning process.

With respect to the specific hypotheses related to usability (HB_1), one prediction was that *Information created and shared in the implemented web-based learning environment tool will have a more cohesive design with a more attractive and updated look with features that appear in modern websites*. Experts felt the COLORS application exemplified a modern 2016 design with information organized in a logical way in order to allow students to easy navigate through the site to register and access course material.

Figure 7-10: Results from the Comparison Study of ChemiNet-COLORS

The first quality measure that was evaluated and discussed in this document is Simple & Natural Dialogue. Based upon the results of the expert evaluation, COLORS proved to have a simple user interface which helps to facilitate the user's navigation of the system. COLORS scored significantly higher than the ChemiNet application. Results can be viewed in Figure 7-11. All ratings were on a 5-point scale, from 1 = Poor and 5 = Excellent.

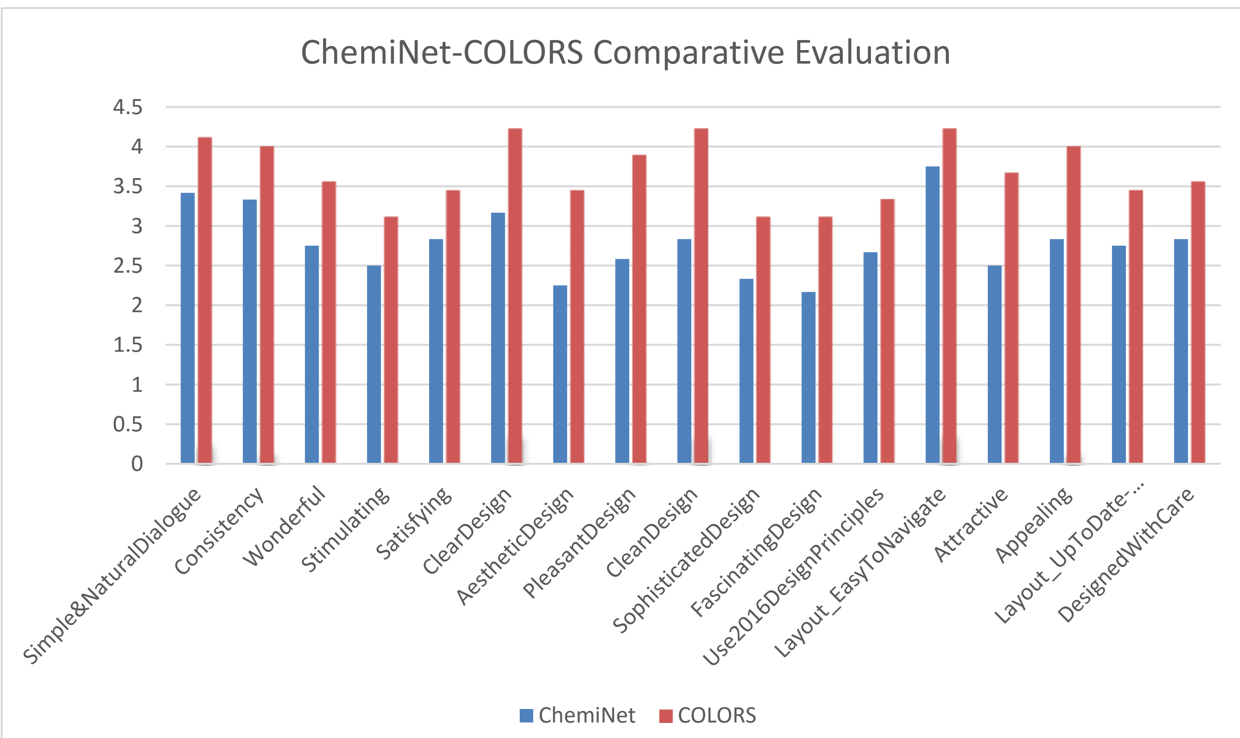
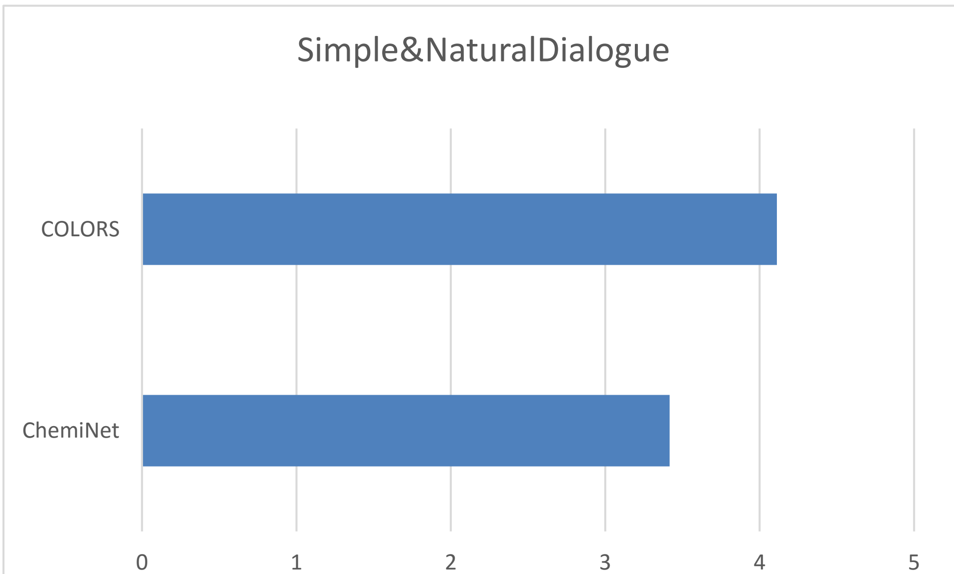


Figure 7-11: Quality Rating By Experts - Simple and Natural Dialogue

Based upon the results, CORLORS has a simpler interface than ChemiNet. About 78%, of the participants felt COLORS provided a simple and natural dialogue. Figure 7-12 shows the frequency distribution of each of the selectable items on the Likert Scale.



Simple_NaturalDialogue	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Average	2	22.22	2	22.22
Above Average	4	44.44	6	66.67
Excellent	3	33.33	9	100.00

Figure 7-12: Frequency – Simple and Natural Dialogue

A univariate analysis was done on collected data. A univariate analysis is an analysis of a single variable. Based upon a small number of participants (N), signed rank was used in order to tell if comparative measure was moving towards significant levels. Our statistical testing revealed that the test mean differences were statistically significant. The researcher attribute these findings to the modern 2016 web design principles used when designing the COLORS application providing a richer and streamlined interface.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	4.264014	**Pr > |t|**	0.0027
Sign	**M**	3.5	**Pr >= |M|**	0.0156
Signed Rank	**S**	14	**Pr >= |S|**	0.0156

Figure 7-13: Univariate – Signed Rank Test

The next quality measure that was evaluated was Consistency. Based upon the results of the expert evaluation, COLORS proved to provide a consistent interface where each page was formatted the same way in order to facilitate user recognition of sections within the application. For example, each course provided the same look and feel with the same left navigation. COLORS scored significantly higher than the ChemiNet application. Results can be viewed in Figure 7-14. All ratings were on a 5-point scale from 1 = Poor and 5 = Excellent.

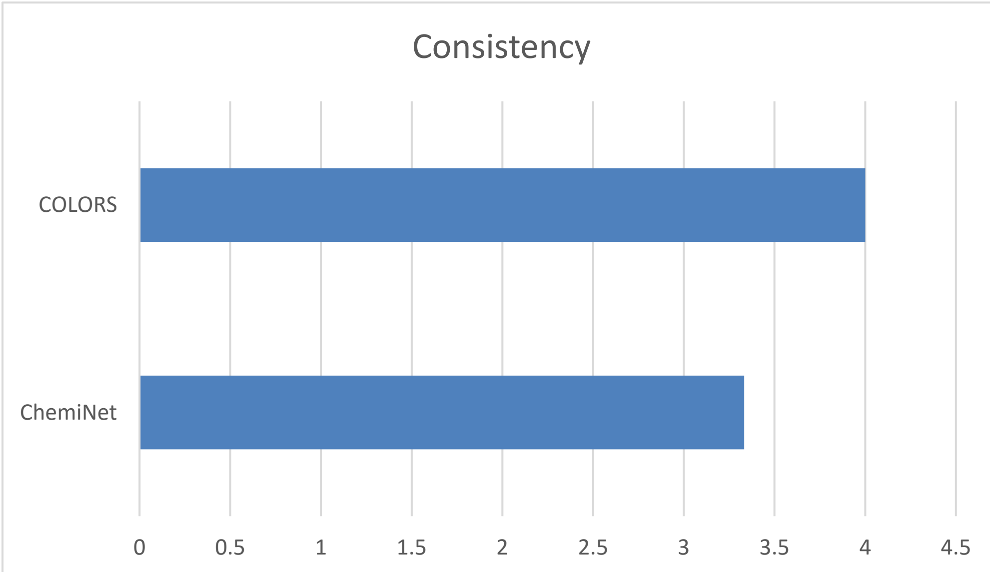


Figure 7-14: Quality Rating By Experts – Consistency

Based upon the results, COLORS has a more consistent user interface. About 78%, of the participants felt COLORS provided a simple and natural dialogue. Figure 7-15 shows the frequency of each of the selectable items on the Likert Scale.

Consistency	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	1	11.11	2	22.22
4	3	33.33	5	55.56
5	4	44.44	9	100.00

Figure 7-15: Frequency – Consistency

The next three (3) quality measure that was evaluated was Wonderful, Stimulating and Satisfying. Based upon the results of the expert evaluation, COLORS proved to provide a wonderful, stimulating and satisfying interface which allows users to clearly navigate and locate key functionality within the user interface for a web-based learning environment. COLORS scored significantly higher than the ChemiNet application in all three (3) areas. Results can be viewed in Figures 7-16, 7-17 and 7-18. All ratings were on a 5-point scale, from 1 = Poor and 5 = Excellent.

Figure 7-16: Quality Rating By Experts - Wonderful

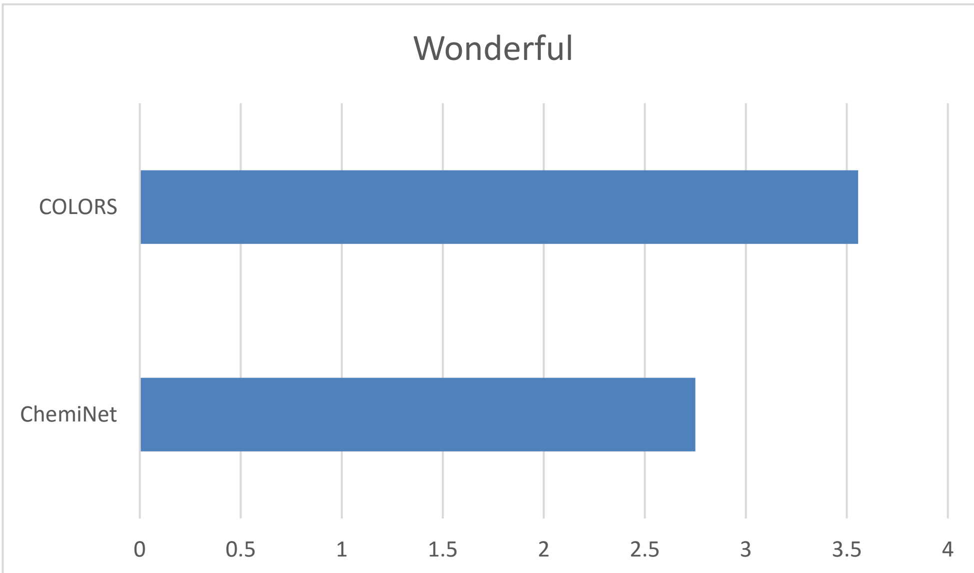
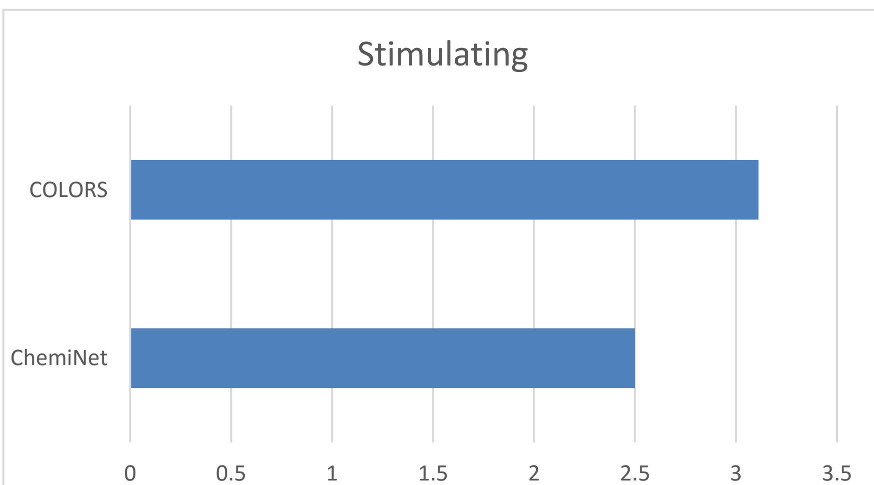


Figure 7-17: Quality Rating By Experts - Stimulating



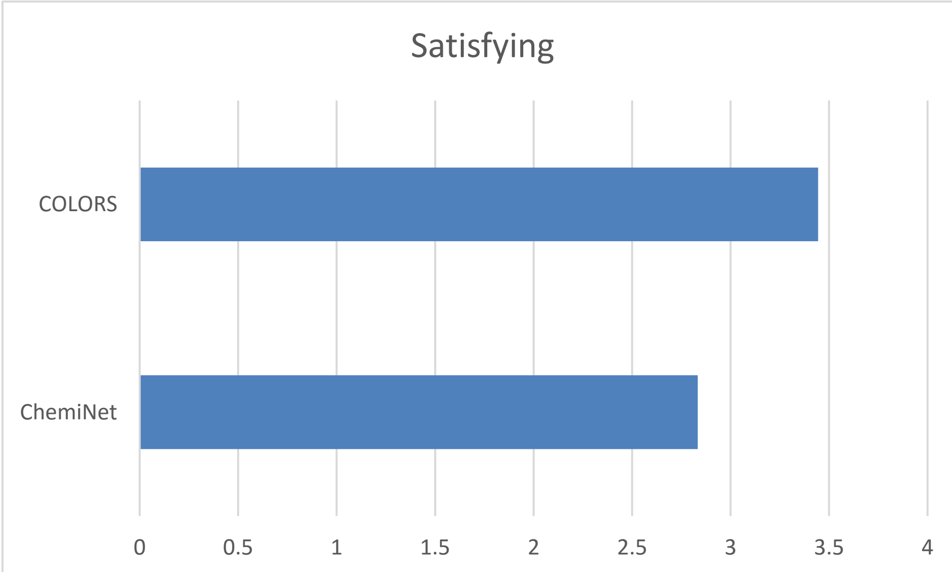


Figure 7-18: Quality Rating By Experts – Satisfying

The next six (6) quality measures that were evaluated focuses on the design of the user interface. These quality measures are clear design, aesthetics design, pleasant design, clean design, sophisticated design, and fascinating design. Based upon the results of the expert evaluation, COLORS proved to provide a high quality design with significant design qualities to support web-based learning. COLORS scored significantly higher than the ChemiNet application in all six (6) areas. Results can be view in Figures 7-19, 7-20, 7-21, 7-22, 7-23 and 7-24. All ratings were on a 5-point scale, from 1 = Poor and 5 = Excellent.

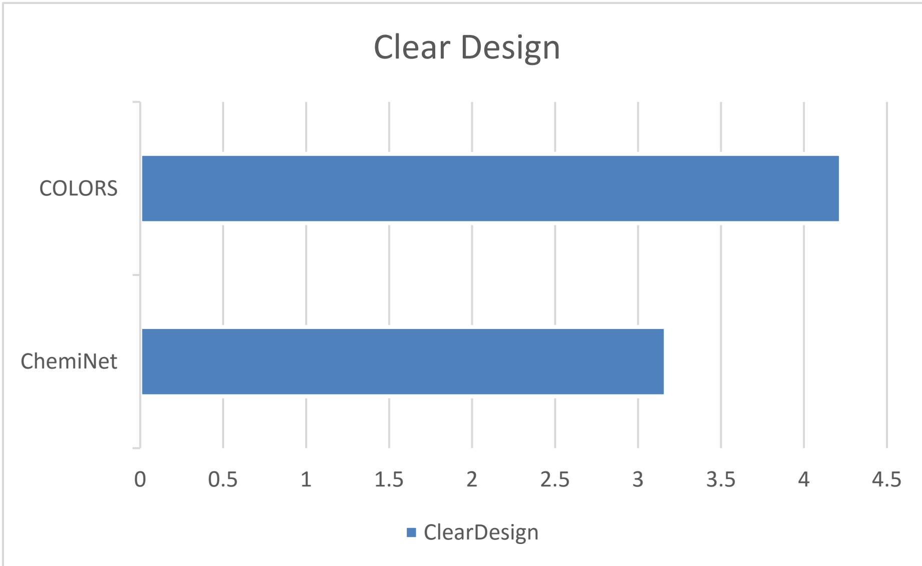


Figure 7-19: Clear Design

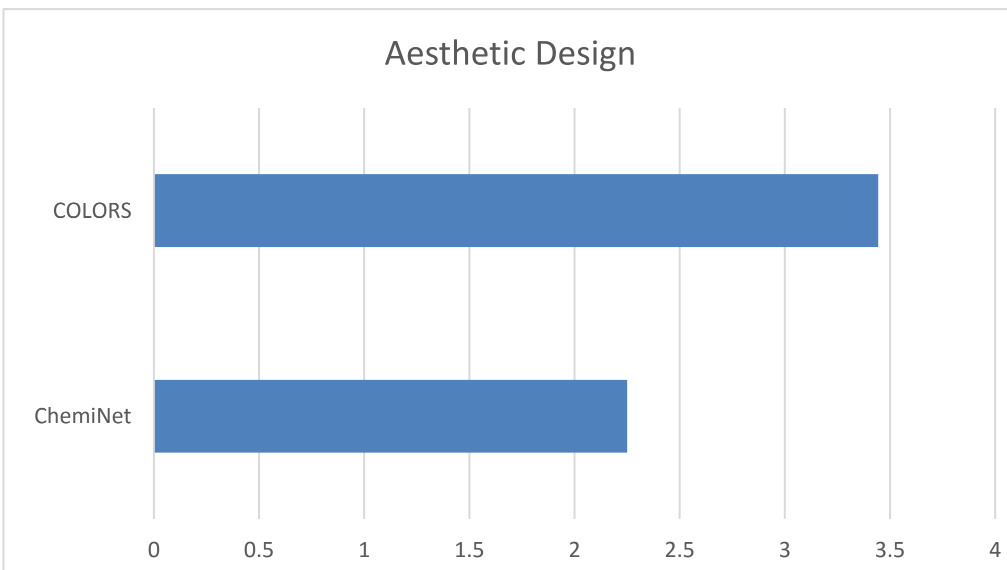


Figure 7-20: Aesthetic Design

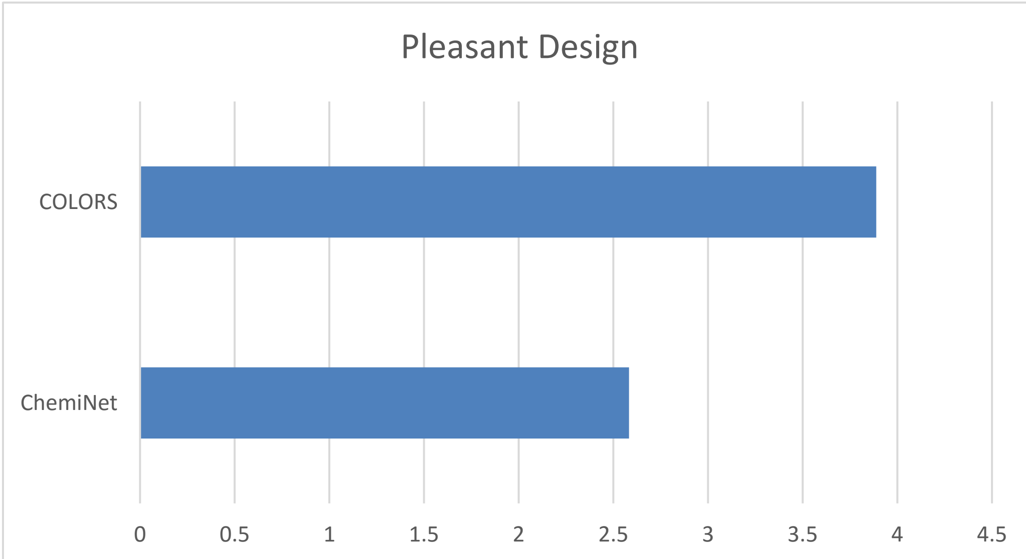


Figure 7-21: Pleasant Design

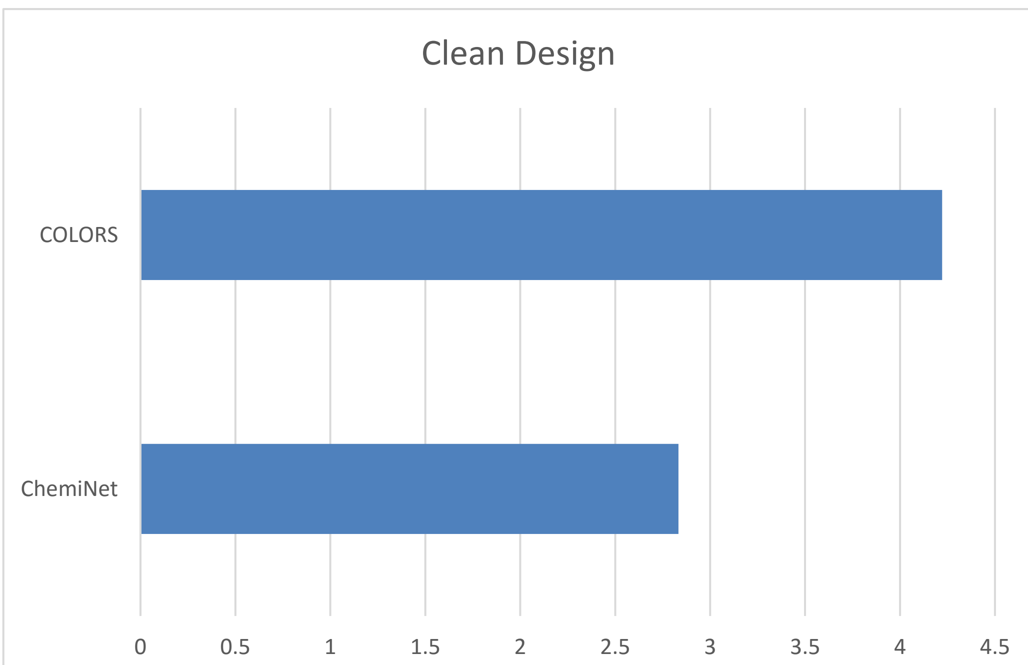


Figure 7-22: Clean Design

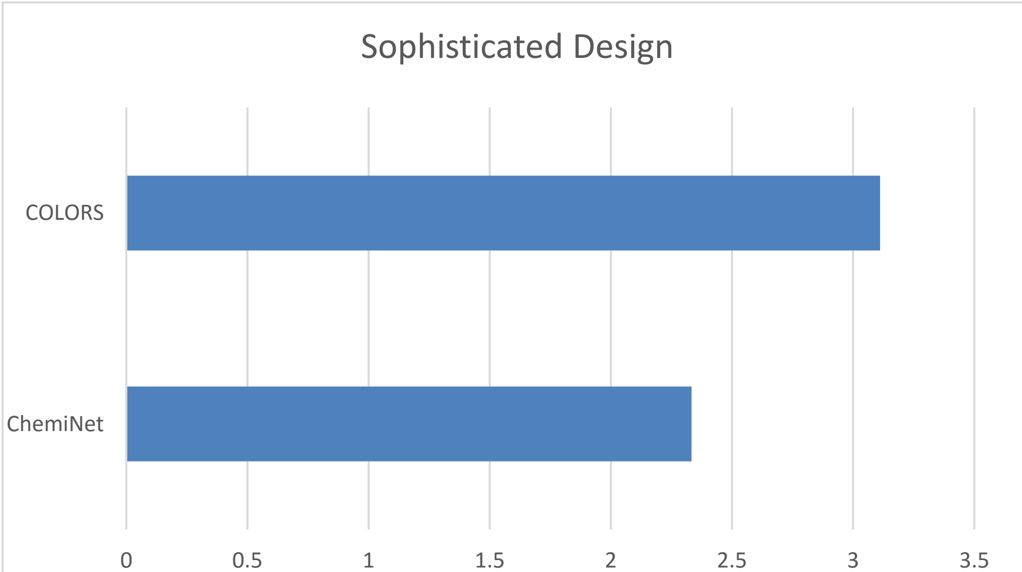


Figure 7-23: Sophisticated Design

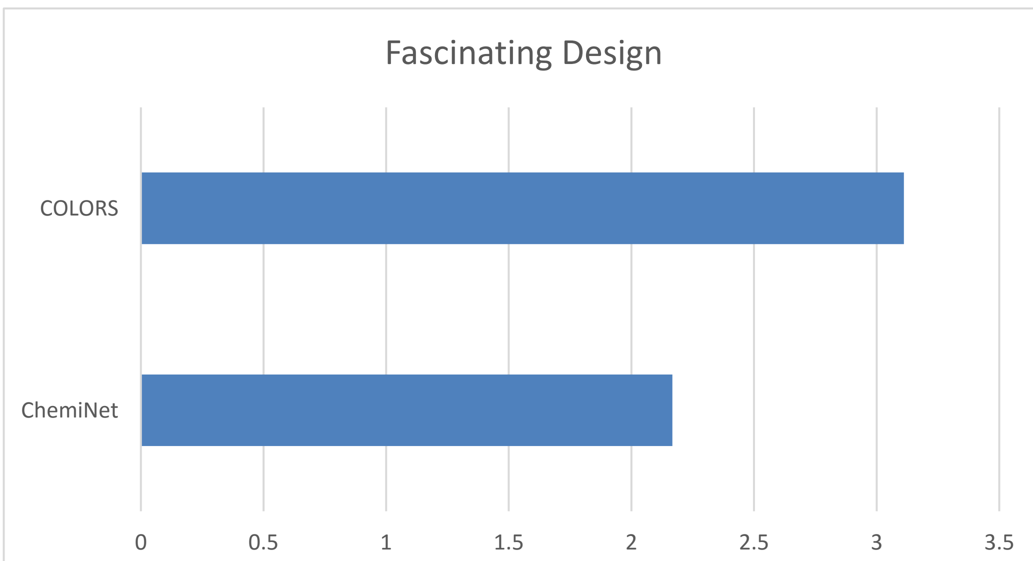


Figure 7-24: Fascinating Design

Out of the results, Clear Design was seen as significant compared to the other qualities. Based upon the results from the expert analysis you can see for Signed Rank , it showed a p value of less than .05. The signed rank Pr>|S| is .0078 that shows this is significant.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	5.5	**Pr > |t|**	0.0006
Sign	**M**	4	**Pr >= |M|**	0.0078
Signed Rank	**S**	18	**Pr >= |S|**	0.0078

Figure 7-25: Univariate – Signed Rank Test

The fact that the experts found the COLORS application more pleasing and a high quality web based learning environment is consistent and reinforces the related findings that the COLORS users were more enthusiastic and pleased about their informal learning experience.

CHAPTER 8: CONCLUSION

Educational content arrives on the web in several ways. Through a Google search, one can find many links to sites, wikis, and blogs for a particular subject. Today, the average user has become substantial contributors of web content, whether using the platform of social media, blogs and wikis, or creating a website using predefined templates. With all of this content, K–12 students need to have an environment that is specifically tailored to their level of education but also provides a wide range of instructional learning modules in a variety of subject areas.

This dissertation investigated the design of a web-based learning environment that aligns with the changing pedagogy of this generation of digital students, documented a set of user-design guidelines that strictly focus on the development of learning environments to support the personalization for a K–12 audience, and developed a platform to enable informal learning by novice users in the dynamic web environment. With these goals, the researcher planned to design and develop a web-based environment for novice users to access resources and course material for a particular subject area. Secondly, the researcher evaluated the design and prototype an application based upon user-design guidelines and proposed improvements to those guidelines based upon usability testing better suited for today's K–12 audiences. Finally, the researcher developed a web-based learning environment that serves as a platform to enable informal learning amongst K–12 students.

The significance of this research is the building of a collaborative and adaptive system to support course that meets the latest design principles to support informal learning. The system was built with a target audience of low-income students because research has shown that students within this population have limited resources for learning beyond what is provided through their department of education.

According to the literature review (Chapter 2), there are systems that support formal learning such as Blackboard and Moodle. These systems are used in a variety of classroom settings to help manage the course and disseminate documents and assessment results back to students. These environments also can be used to facilitate discussion on topics outside of the classroom. The hope for this research was to leverage informal learning to support gaps in the educational offering of low-income communities.

To focus the research, the researcher identified four research questions:

RQ1: With what aspects of informal learning would individuals in low-income areas like to see offered that they don't have access to now and what type of considerations need to be made when providing these types of courses? What type of learning activities would they like to see?

During the preliminary research study (Chapter 4), the researcher found that most participants had an interest in STEM-related courses. Moreover, according to the participants' background/school information, there is a lack of advanced courses offered within high schools in low-income communities. Courses related to Advanced Placement (AP) examinations were identified as a beneficial option for students within the participant group. During the comparative study (Chapter 7), the data showed students prefer courses with videos vs. non-video courses. Based upon this information, the researcher was able to determine the type of learning activities individuals in this target population would like to see in an informal learning environment.

RQ2: What types of factors (usability and security) need to be engaged in order to provide a usable and secure environment for the K–12 audience? RQ2a: Are there any key usability issues that face K–12 students when trying to learn within an informal learning environment (Jacob Neilson Guidelines)?

During the summative assessment (Chapter 7), expert evaluators looked at forty-three design standards for usable web-based environments and evaluated the proposed environment against each of the metrics. Based upon the comparative study (Chapter 7), several of those metrics were significant. Below is a graph of significant factors.

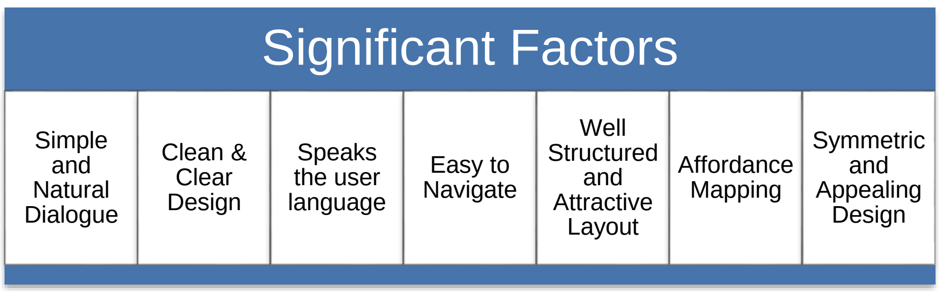


Figure 8.1: Significant Factors

Based on the summative assessment (Chapter 7) done by students, the researcher found that these metrics needed to be in place in order to provide an easy-to-use, easy-to-navigate and easy-to-learn web interface to support informal learning.

RQ3: In what ways does providing informal learning courses affect how students feel about the quality of education they are receiving? RQ3a: Based on the course they participated in, do they feel an increase understanding in the subject area and/or felt it was valuable information?

The statement of the quality of education is something that is hard to asses. This research focused on whether students would appreciate receiving information in an eLearning form, not on the general quality of education from their local institution.

The question is clarified as follows: "In what ways does providing informal learning courses affect how students feel about the satisfaction of the type of instruction received from the online learning environment (i.e., quality of education). Based upon the summative assessments (Chapter 7), the researcher demonstrated that participants enjoyed the interactivity of the environment. The ideas shown in the literature (Chapter 2) support formal learning, but this is a support for informal learning.

RQ4: Do students feel that they can and are improving their knowledge in various subjects offered by completing courses within the informal learning environment?

The final results from the summative assessment (Chapter 7) showed that 100% of the students would recommend the COLORS application (Chapter 6) to support informal learning. The impact COLORS had on the knowledge of students was validated by the participants' observation during the study. Students were collaborating and discussing content presented in the courses testing the knowledge gained from interacting with course material through COLORS (Chapter 6).

This dissertation research will make three unique contributions. First, the researcher evaluated the current prototype of an informal learning environment to gather additional user-design guidelines that focus on developing an application for novice K–12 users. One example of such guidelines is scrolling, where a page may be too large to show within the folds of a site causing the user to have to side the page over horizontally and vertically. This leaves data or controls that the user may need out of their sight. In this work, the researcher developed guidelines showing alternatives for designing web-based learning environments, by using a drill-down method approach when displaying large amount of text, which allows the user to digest small chunks of information at a time and drill down if more understanding is needed and, ultimately, take up less valuable screen room causing minimal or no scrolling.

Second, since users interact with the web-based learning environment through browsers, the researcher conducted a functional analysis of the incoherencies in current browser functions that may pose problems for novice users. One example of such a discrepancy is that current browsers support certain features that allow different functions to be shown or change the look and feel of different controls. By uncovering such disparities, the researcher enumerated all possibilities of control irregularities from the browser and suggested ways to prevent look and feel differences across browsers. This ultimately provided a cohesive look and feel no matter which browser a student uses and motivate the adoption of the application.

Finally, researcher developed a web-based learning environment, called COLORS, to support the informal learning of a wide range of subjects that can be accessed by K–12 students based upon the user-centered design process as defined by ISO-9241-210. The ISO standard outlines six principles of human-centered design:

- The design is based upon an explicit understanding of users, tasks, and environments.
- Users are involved throughout design and development.
- The design is driven and refined by user-centered evaluation.
- The process is iterative.
- The design addresses the whole user experience.
- The design team includes multidisciplinary skills and perspectives [1]

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https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-1:v1:en

On the one hand, the platform increased students' flexibility in course options and allowed them to personalize their learning experience; on the other hand, it allowed low-income or budget-strapped K–12 school districts to give their students options to take courses that cannot be offered due to financial factors.

8.1 Contributions

The contribution of this research is beneficial to computer-supported collaborative learning (CSCL) design, human computer interaction research, virtual environments, informal learning research, usability studies research and computer science. The following contributions have been made:

1. Research study critiques many of the modern course delivery and management system as well as informal learning web environments available to support learning at the collegiate or K–12 level.
2. Contributes to the limited literature on under-resource schools.
3. Introduced a new system for increasing the availability of courses among low income K–12 students
    a. The COLORS System provides a rich and interactive learning environment to support informal learning, where K–12 students can enroll and take courses related to the STEM area.
4. A new method and criteria to validate a collaborative tool for use in a K–12 environment to support informal learning is presented with lower cost associated with it compared to other robust course/learning management tools.

5. A framework for the development of a course delivery tool for K–12 students in support of informal learning was developed using the established requirements identified in this reach study.
6. A minimalist design was developed and used in order to create an environment to support students with little or no prior web-based course experience.

8.2 Future Work

This work has provided a foundation and clear path for research to continue in the areas of informal learning and computer-support collaborative learning. Future work should attempt to expand the targeted population for COLORS application. This work should continue to seek ways to make the system more flexible and easier to use for instructors through conducting an initial study with the high school teachers.

Future work should attempt to focus on a longitudinal study to support additional resources through grant support. During the longitudinal study, the focus should be on participatory design and iterative redesign. Lastly, this work should continue to seek ways to promote the implemented application as a national platform for support under resource populations.

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APPENDIX A

PRE-QUESTIONNAIREs from the ChemiNet Study

(referenced in Chapter 3)

Pre-Survey 1: User Experience Survey

1. Enter Survey Identification Number: _____________

2. What grade level are you?
   - 9th
   - 10th
   - 11th
   - 12th
   - Other: ________

3. How often do you use a computer?
   - Never used one
   - One or two times a month
   - Once a week
   - Every day

4. Where do you normally use a computer? (Select all that apply)
   - No access to a computer
   - Home
   - School
   - Library
   - Friend's home
   - Work
   - Other: _____________

5. If you selected “Home” as an answer to the above question, how do you access the Internet

- modem (dial-up)
- cable
- DSL
- Don't know
- Other: ____________

6. What do you normally use a computer for? (Select all that apply)

- E-mal
- Surfing the Internet
- Maintaining social network sites such as Facebook and Twitter
- Gaming
- Homework
- Blogging
- Work (other than school work)

7. Do you have an e-mail?

- Yes - No

8. What type of software are you most comfortable with? (Select all that apply)

- Internet browser
- E-mail software
- Word Processing (MS Word, etc.)
- Spreadsheet (MS Excel, etc.)
- Gaming Software

9. What browser do you feel most comfortable with when using the Internet?

- Internet Explorer
- Firefox
- Google Chrome
- Safari
- Opera
- Other: ____________

10. How comfortable do you feel with using a computer?

- Very comfortable
- Quite comfortable
- Somewhat comfortable
- Not very comfortable
- Not at all comfortable

Pre-Survey 2: Web-Based Learning Environment/Periodic Table Experience

1. Enter Survey Identification Number: _____________

2. What grade level are you?
    - 9th
    - 10th
    - 11th
    - 12th
    - Other: ________

3. Do you have prior experience working in a web-based learning environment? (i.e. Blackboard, Moodle)
    - Yes
    - No

4. Have you taken a high school Chemistry course?
    - Yes
    - No

5. Are you familiar with the periodic table of elements?
    - Yes
    - No

6. Have you taken a course over the Internet?
    - Yes
    - No

7. If you had the option to take an online course for a major subject, would you enroll in the online course over the traditional classroom course?
    - Yes
    - No

8. Do you feel you and your peers can learn better through web-based learning environments?
    - Yes
    - No

APPENDIX B

POST-QUESTIONNAIRE from the ChemiNet Study

referenced in Chapter 3

Post Survey 1: User Experience with Online Web Application

1. Enter Survey Identification Number:

Questions 2 – 8	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2. I thought the website was great.					
3. I thought the overall application was exciting					
4. I thought the lessons were easy to navigate through					
5. I thought the website was fun					
6. I thought the quizzes were challenging					
7. I felt the website interface design fit my character					
8. The help section of the ChemiNet application provided adequate support					

Post-Survey 2: Overall Ease of Use of the ChemiNet Application

1. Enter Survey Identification Number:

Questions 2 – 8	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2. I liked the overall appearance of the ChemiNet application.					
3. I understood how to navigate through the ChemiNet application.					
4. I feel that people with limited computer experience could use the ChemiNet application.					
5. The ChemiNet application makes it easy for teachers to reinforce material already presented in the classroom in the form of a traditional lesson.					
6. I think the ChemiNet application should be used in more classrooms					
7. I feel the interactive periodic table with the ChemiNet application is better than a normal paper version of the periodic table.					
8. The ChemiNet application reinforced basic chemistry knowledge.					

APPENDIX C

IRB Application for Research Study

AUBURN UNIVERSITY INSTITUTIONAL REVIEW BOARD for RESEARCH INVOLVING HUMAN SUBJECTS

RESEARCH PROTOCOL REVIEW FORM
FULL BOARD or EXPEDITED

For Information or help contact **THE OFFICE OF RESEARCH COMPLIANCE (ORC)**, 115 Ramsay Hall, Auburn University
Phone: 334-844-5966 **e-mail:** IRBAdmin@auburn.edu **Web Address:** http://www.auburn.edu/research/vpr/ohs/index.htm

Revised 2.1.2014 **Submit completed form to IRBsubmit@auburn.edu or 115 Ramsay Hall, Auburn University 36849.**

Form must be populated using Adobe Acrobat / Pro 9 or greater standalone program (do not fill out in browser). Hand written forms will not be accepted.

1. PROPOSED START DATE of STUDY: March 1, 2016

PROPOSED REVIEW CATEGORY (Check one): ☑ **FULL BOARD** ☐ **EXPEDITED**

SUBMISSION STATUS (Check one): ☐ **NEW** ☐ **REVISIONS (to address IRB Review Comments)**

2. PROJECT TITLE: A Collaborative Adpative-based Web-Based Environment to Support Informal Learning Technology Design

3.

Candice Adams	PhD Candidate	Computer Science and	harri15@auburn.edu
PRINCIPAL INVESTIGATOR	**TITLE**	**DEPT**	**AU E-MAIL**
1355 Commerce Drive, Apt. 508, Auburn, AL 36830		404-939-7173	candice.h.adams@
MAILING ADDRESS		**PHONE**	**ALTERNATE E-MAIL**

4. FUNDING SUPPORT: ☑ N/A ☐ Internal ☐ External Agency: ________ ☐ Pending ☐ Received

For federal funding, list agency and grant number (if available).

5a. List any contractors, sub-contractors, other entities associated with this project:

b. List any other IRBs associated with this project (including Reviewed, Deferred, Determination, etc.):

PROTOCOL PACKET CHECKLIST

All protocols must include the following items:

- ☑ **Research Protocol Review Form** (All signatures included and all sections completed)
  (Examples of appended documents are found on the OHSR website: http://www.auburn.edu/research/vpr/ohs/sample.htm)
- ☑ **CITI Training Certificates** for all Key Personnel.
- ☑ **Consent Form or Information Letter** and any Releases (audio, video or photo) that the participant will sign.
- ☑ **Appendix A**, "Reference List"
- ☑ **Appendix B** if e-mails, flyers, advertisements, generalized announcements or scripts, etc., are used to recruit participants.
- ☑ **Appendix C** if data collection sheets, surveys, tests, other recording instruments, interview scripts, etc. will be used for data collection. Be sure to attach them in the order in which they are listed in # 13c.
- ☐ **Appendix D** if you will be using a debriefing form or include emergency plans/procedures and medical referral lists (A referral list may be attached to the consent document).
- ☐ **Appendix E** if research is being conducted at sites other than Auburn University or in cooperation with other entities. A **permission letter** from the site / program director must be included indicating their cooperation or involvement in the project. NOTE: If the proposed research is a multi-site project, involving investigators or participants at other academic institutions, hospitals or private research organizations, a letter of **IRB approval** from each entity is required prior to initiating the project.
- ☐ **Appendix F** - Written evidence of acceptance by the host country if research is conducted outside the United States.

FOR ORC OFFICE USE ONLY

DATE RECEIVED IN ORC:		**by**		**PROTOCOL #**	
DATE OF IRB REVIEW:		**by**		**APPROVAL CATEGORY:**	
DATE OF IRB APPROVAL:		**by**		**INTERVAL FOR CONTINUING REVIEW:**	
COMMENTS:					

6. **GENERAL RESEARCH PROJECT CHARACTERISTICS**

6A. Research Methodology

Please check all descriptors that best apply to the research methodology.

Data Source(s): ☑ New Data ☐ Existing Data

Will recorded data directly or indirectly identify participants? ☐ Yes ☑ No

Data collection will involve the use of:

- ☐ Educational Tests (cognitive diagnostic, aptitude, etc.)
- ☐ Interview
- ✓ Observation
- ☐ Location or Tracking Measures
- ☐ Physical / Physiological Measures or Specimens (see Section 6E.)
- ✓ Surveys / Questionnaires
- ✓ Internet / Electronic
- ☐ Audio
- ☐ Video
- ☐ Photos
- ☐ Digital images
- ☐ Private records or files
- ☐ Other:

6B. Participant Information

Please check all descriptors that apply to the target population.

☑ Males ☑ Females ☑ AU students

Vulnerable Populations

☐ Pregnant Women/Fetuses ☐ Prisoners ☐ Institutionalized

☑ Children and/or Adolescents (under age 19 in AL)

Persons with:

☐ Economic Disadvantages ☐ Physical Disabilities

☐ Educational Disadvantages ☐ Intellectual Disabilities

Do you plan to compensate your participants? ☐ Yes ☑ No

6C. Risks to Participants

Please identify all risks that participants might encounter in this research.

☑ Breach of Confidentiality* ☑ Coercion

☐ Deception ☐ Physical

☐ Psychological ☐ Social

☐ None

☐ Other: Adults, AU grad. students will ask to voluntary participate and can withdraw at anytime. The decision whether to participate or not to participate will not impact the student. Adults, AU grad. students will not be in the Professor's current class but could be a former student.

*Note that if the investigator is using or accessing confidential or identifiable data, breach of confidentiality is always a risk.

6D. Corresponding Approval/Oversight

- Do you need IBC Approval for this study?
  ☐ Yes ☑ No

  If yes, BUA # ____________ Expiration date ____________

- Do you need IACUC Approval for this study?
  ☐ Yes ☑ No

  If yes, PRN # ____________ Expiration date ____________

- Does this study involve the Auburn University MRI Center?
  ☐ Yes ☑ No

  Which MRI(s) will be used for this project? (Check all that apply)
  ☐ 3T ☐ 7T

  Does any portion of this project require review by the MRI Safety Advisory Council?
  ☐ Yes ☑ No

  Signature of MRI Center Representative: ____________________
  Required for all projects involving the AU MRI Center

  Appropriate MRI Center Representatives:
  Dr. Thomas S. Denney, Director AU MRI Center
  Dr. Ron Beyers, MR Safety Officer

7. PROJECT ASSURANCES A Collaborative Adpative-based Web-Based Environment to Support Informal Learning Technology Design

A. PRINCIPAL INVESTIGATOR'S ASSSURANCES

1. I certify that all information provided in this application is complete and correct.
2. I understand that, as Principal Investigator, I have ultimate responsibility for the conduct of this study, the ethical performance this project, the protection of the rights and welfare of human subjects, and strict adherence to any stipulations imposed by the Auburn University IRB.
3. I certify that all individuals involved with the conduct of this project are qualified to carry out their specified roles and responsibilities and are in compliance with Auburn University policies regarding the collection and analysis of the research data.
4. I agree to comply with all Auburn policies and procedures, as well as with all applicable federal, state, and local laws regarding the protection of human subjects, including, but not limited to the following:
   a. Conducting the project by qualified personnel according to the approved protocol
   b. Implementing no changes in the approved protocol or consent form without prior approval from the Office of Research Compliance
   c. Obtaining the legally effective informed consent from each participant or their legally responsible representative prior to their participation in this project using only the currently approved, stamped consent form
   d. Promptly reporting significant adverse events and/or effects to the Office of Research Compliance in writing within 5 working days of the occurrence.
5. If I will be unavailable to direct this research personally, I will arrange for a co-investigator to assume direct responsibility in my absence. This person has been named as co-investigator in this application, or I will advise ORC, by letter, in advance of such arrangements.
6. I agree to conduct this study only during the period approved by the Auburn University IRB.
7. I will prepare and submit a renewal request and supply all supporting documents to the Office of Research Compliance before the approval period has expired if it is necessary to continue the research project beyond the time period approved by the Auburn University IRB.
8. I will prepare and submit a final report upon completion of this research project.

My signature indicates that I have read, understand and agree to conduct this research project in accordance with the assurances listed above.

Candice Adams	Candice Adams	12/4/2015
Printed name of Principal Investigator	**Principal Investigator's Signature**	**Date**

B. FACULTY ADVISOR/SPONSOR'S ASSURANCES

1. I have read the protocol submitted for this project for content, clarity, and methodology.
2. By my signature as faculty advisor/sponsor on this research application, I certify that the student or guest investigator is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accord with the approved protocol.
3. I agree to meet with the investigator on a regular basis to monitor study progress. Should problems arise during the course of the study, I agree to be available, personally, to supervise the investigator in solving them.
4. I assure that the investigator will promptly report significant incidents and/or adverse events and/or effects to the ORC in writing within 5 working days of the occurrence.
5. If I will be unavailable, I will arrange for an alternate faculty sponsor to assume responsibility during my absence, and I will advise the ORC by letter of such arrangements. <u>If the investigator is unable to fulfill requirements for submission of renewals, modifications or the final report, I will assume that responsibility.</u>

Cheryl Seals	Cheryl Seals	12/4/2015
Printed name of Faculty Advisor / Sponsor	**Faculty Advisor's Signature**	**Date**

C. DEPARTMENT HEAD'S ASSSURANCE

By my signature as department head, I certify that I will cooperate with the administration in the application and enforcement of all Auburn University policies and procedures, as well as all applicable federal, state, and local laws regarding the protection and ethical treatment of human participants by researchers in my department.

Dr. Kai Chang	Kai H Chang	12/4/2015
Printed name of Department Head	**Department Head's Signature**	**Date**

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8. PROJECT OVERVIEW: Prepare an abstract that includes:
(350 word maximum, in language understandable to someone who is not familiar with your area of study):

a) A summary of relevant research findings leading to this research proposal:
(Cite sources; include a "Reference List" as Appendix A.)

b) A brief description of the methodology, including design, population, and variables of interest

a) Technology is instrumental to the digital age that we live because digital technologies are accessible to nearly everyone in all parts of the world we live in today. Hence, web-based learning environments are more prevalent and are pursued by students who are looking to advance their knowledge in a particular subject area. With the widespread user access of the Internet, it has become the primary tool used to deliver educational content. Therefore, HCI researchers and developers have been challenged with improving usability of these web-based products. With the introduction of these two key components cloud-based/web-based learning environments have the potential to impact learning even greater.

b) The participants in this study will be middle to high school ages students, both male and female. The study will focus on a population of middle to high school students.

A minimum number of 30 participants are expected to participate in this study. All participants (13 -17) will be required to have a signed permission slip from their parents and/or guardian. The participants will be asked to read the information letter used to inform the participant of his or her rights in participating in this study. The participants will be given a parental consent letter to be completed by the parent or guardian.

All participants will be informed not to discuss the experiment with friend and classmates to ensure that all participants had an equal knowledge of the study. If participants are taken from a group population such as Upward Bound, they have already consented for such studies during application process so no consent form will be given to each of the participants.

Upward Bound provides fundamental support to participants in their preparation for college entrance. The program provides opportunities for participants to succeed in their precollege performance and ultimately in their higher education pursuits. Upward Bound serves: high school students from low-income families; and high school students from families in which neither parent holds a bachelor's degree. Students are ages 13 - 18.

All Students regardless if taken from the Upward Bound will be given a parental consent form.

Adults, including AU grad students will sign a regular consent form without parental consent.

9. PURPOSE.

a. Clearly state the purpose of this project and all research questions, or aims.

The objective of this research is to explore web-based learning environments and determine how they can enhance learning for students by increasing course availability in K-12 education. Two particular ways web-based environments can enhance learning is through adaptability and sociability. Our approach includes creating an environment where students in K-12 education can enroll and take courses while interacting with other students from different locations who are enrolled in the same course. The immediate contributions of this research will increase students' knowledge in a particular subject area in K-12 STEM field. In addition, the results of this research may capture and generate interest within the computer-supported collaborative learning community. Our experiment aims to developed a set of user design guidelines through usability evaluation of the varies application interfaces.

b. How will the results of this project be used? (e.g., Presentation? Publication? Thesis? Dissertation?)

The results of this project will be used in a dissertation, publications and Conference presentations.

10. KEY PERSONNEL. Describe responsibilities. Include information on research training or certifications related to this project. **CITI is required. Be as specific as possible.** (Include additional personnel in an attachment.) ***All key personnel must attach CITI certificates of completion.***

Principle Investigator Candice Adams **Title:** PhD Candidate **E-mail address** harri15@auburn.edu

Dept / Affiliation: Computer Science and Software Engineering

Roles / Responsibilities:

Coordinate and manage the development of the research. A Internet based software application will be developed in an effort to increase STEM achievement. I will facilitate the development and implementation of the application.

Individual: Cheryl Seals **Title:** Assoc. Prof. **E-mail address** sealscd@auburn.edu

Dept / Affiliation: Computer Science and Software Engineering

Roles / Responsibilities:

Coordinate the work described as stated above in the design, development and evaluation of the software application.

Individual: ____ **Title:** ____ **E-mail address** ____

Dept / Affiliation: ____

Roles / Responsibilities:

Individual: ____ **Title:** ____ **E-mail address** ____

Dept / Affiliation: ____

Roles / Responsibilities:

Individual: ____ **Title:** ____ **E-mail address** ____

Dept / Affiliation: ____

Roles / Responsibilities:

Individual: ____ **Title:** ____ **E-mail address** ____

Dept / Affiliation: ____

Roles / Responsibilities:

11. LOCATION OF RESEARCH. List all locations where data collection will take place. (School systems, organizations, businesses, buildings and room numbers, servers for web surveys, etc.) **Be as specific as possible. Attach permission letters in Appendix E.**
(See sample letters at http://www.auburn.edu/research/vpr/ohs/sample.htm)

Auburn University - Shelby Center Room 2XXX. If student can't make it onsite. They will be given the option to complete the survey online using survey monkey.

5

12. PARTICIPANTS.

a. Describe the participant population you have chosen for this project including inclusion or exclusion criteria for participant selection.

☐ **Check here if using existing data, describe the population from whom data was collected, & include the # of data files.**

Participants in the web-based learning environment part of the study conducted for a group K-12 students. the population group can be ages 13 - 17. At least 30-60 middle and high school students will be selected to participate in the study. All participants will be given a parental consent form.

Inclusion criteria: males and females 13-17 years old with some experience using computers and browsing the Internet.

In addition, Adults, AU graduate students with experience in usability studies will review the application as well.

b. Describe, step-by-step, in layman's terms, all procedures you will use to recruit participants. *Include in Appendix B a copy of all e-mails, flyers, advertisements, recruiting scripts, invitations, etc., that will be used to invite people to participate.* *(See sample documents at http://www.auburn.edu/research/vpr/ohs/sample.htm.)*

All participants will be recruited from local middle/high school surrounding the Auburn area. A recruitment script will be sent to each of the following schools: Auburn High, Opelika HS, Booker T. Washington HS, Beauregard HS, Drake MS, Auburn Junior High, Notasulga School, Each participant must be ages 13 - 17. The recruitment script will be used at the local Upward Bound program to invite student to participate.

Adults, AU graduate students, will be invited by their professor and if they elect to participate, the professor will give a consent form that they must sign and return in order to participate in this study. Auburn University will recruit Adults, AU graduate students over 19 years of age who have completed research in Human Computer Interaction, Usability, Training or Educational design and Development. No parental consent will be used for Adults, AU graduate students.

c. What is the minimum number of participants you need to validate the study? 40

How many participants do you expect to recruit? 60

Is there a limit on the number of participants you will include in the study? ☑ **No** ☐ **Yes – the # is** ________

d. Describe the type, amount and method of compensation and/or incentives for participants.

(If no compensation will be given, check here: ☑)

Select the type of compensation: ☐ Monetary ☐ Incentives

☐ Raffle or Drawing incentive (Include the chances of winning.)

☐ Extra Credit (State the value)

☐ Other

Description:

6

13. **PROJECT DESIGN & METHODS.**

a. **Describe, step-by-step, all procedures and methods that will be used to consent participants. If a waiver is being requested, check each waiver you are requesting, describe how the project meets the criteria for the waiver.**

- ☐ **Waiver of Consent (including using existing data)**
- ☐ **Waiver of Documentation of Consent (use of Information Letter)**
- ☐ **Waiver of Parental Permission (for college students)**

All participants will be recruited from local middle/high school surrounding the Auburn area. Each participant must be ages 13 - 17.

Each participant will be given a consent form. Consent forms must be signed by parent or guardian before participating in the study.

Adults, AU grad., will be invited by their professor and if they elect to participate, the professor will give a consent form that they must sign and return in order to participate in this study. Participants will be over 19 years of age who have completed research in Human Computer Interaction, Usability, Training or Educational design and Development.

b. **Describe the research design and methods you will use to address your purpose. Include a clear description of when, where and how you will collect all data for this project.** Include specific information about the participants' time and effort commitment. (*NOTE: Use language that would be understandable to someone who is not familiar with your area of study. Without a complete description of all procedures, the Auburn University IRB will not be able to review this protocol. If additional space is needed for this section, save the information as a .PDF file and insert after page 7 of this form.*)

Each student will be asked to complete a parent's consent and children's assent to join the study. Each student will then participate in a study of completing a course from the system.

The participants in this study will be middle to high school ages students, both male and female. The study will focus on middle and high school students ages 13- 17.

The participants will be asked to read the information letter used to inform the participant of his or her rights. in participating in this study. The participants will be given a parental consent letter to be completed by the parent or guardian. All participants will be informed not to discuss the experiment with friends and classmates to ensure that all participants had an equal knowledge of the study.

The first method of data collection for the study will be done through the pre-questionnaire. Each participant is required to fill out the pre-questionnaire so that demographic information about the participants can be collected. Each pre-questionnaire will be give a unique identifier so that the information can be paired with the information collected during the experiment. Demographic information is needed to determine the type of participants in the study. The part should not take more than 15 minutes

During the study, information will ge gathered to analyze the participants use of the system. The participant will complete Science, Technology, Engineering, or Math (STEM) lessons within the system. The lesson they choose to do is completely up to the participant. They will also be ask to complete at least one quiz for that lesson. This part should not take more than 30 minutes. They will be given up to 45 minutes to complete this section.

Lastly, each student will be asked to do a post-questionnaire. The post-questionnaire will be given to each student. They will be asked to use the same unique identifier given during the pre-questionnaire. The post questionnaire will focus on basic usability questions. The results from the pre-questionnaire and post-questionnaire as well as information gathered through observation will be presented in this study. The post-questionnaire should not take more than 15 minutes to complete. The entire study will take approx. 1 hour and 30 minutes.

Each Adult, AU grad student will be given a the Jakob Nielsen 10 herustics and will be asked to do an evaluation of the application based upon those 10 herustics. These are included as an appendix. They will be asked to come together in a group setting to discuss/present their findings.

13. **PROJECT DESIGN & METHODS.** *Continued*

c. **List all data collection instruments used in this project, in the order they appear in** Appendix C.
(e.g., surveys and questionnaires **in the format that will be presented to participants**, educational tests, data collection sheets, interview questions, audio/video taping methods etc.)

d. **Data analysis: Explain how the data will be analyzed.**

14. **RISKS & DISCOMFORTS: List and describe all of the risks that participants might encounter in this research.** ***If you are using deception in this study, please justify the use of deception and be sure to attach a copy of the debriefing form you plan to use in*** *Appendix D.* *(Examples of possible risks are in section #6D on page 2)*

There are mininal risks or discomforts associated with this research. There is a remote chance of breach of confidentiality becasue of recruting Adults, AU grad. students that the Professor know. Also, we are not collecting any confidentail or identifiable information from participants, but we will take all necessary precautions to safegurad completed surveys. High School students 13 - 17, will be given a random code but their name or any other information will not be associated with the code. All surveys will be destroyed after data has been analyzed and reported/published. Data will not be kept more than 3 years after data has been analyzed and reported/published.

We anticipate our study will contain a longitudinal effort of which the period of activity is determined by the user as the activities are self-paced. The users will log into a website to access materials and all efforts will be made to keep the data collection anonymous. There is a remote possibility that the data might be compromised despite established guards. The subject will be advised of their rights to refuse to complete any parts of the study and to terminate their participation at any time. For application evaluation experts there are no risks as the period will be short enough as not to cause distress.

Adults, AU graduate students. There are no risks or discomforts associated with this research. We anticipate that our study will contain a longitudinal effort of which each period of activity is determined by the user as the activities are self paced. The users will log into a website to access materials and all efforts will be made to keep the data collection anonymous. There is a remote possibility that the data might be compromised despite established guards. The subject will be advised of their rights to refuse to complete any parts of the study and to terminate their participation at any time. For application evaluation experts there are no risks as the period be short enough as not to cause distress. Adults, AU grad. students will be asked to voluntarily participate and can withdraw at anytime. The decision whether to participate or not to participate will not impact the student. Adults, AU grad. students will not be in the Professor's current class but could be a former student.

15. PRECAUTIONS. Identify and describe all precautions you have taken to eliminate or reduce risks as listed in #14. If the participants can be classified as a "vulnerable" population, please describe additional safeguards that you will use to assure the ethical treatment of these individuals. ***Provide a copy of any emergency plans/procedures and medical referral lists in Appendix D.*** ***(Samples can be found online at http://www.auburn.edu/research/vpr/ohs/sample.htm#precautions)***

In order to help prevent and eliminate risks all participants will be asked to keep all information shared confidential. We will also be utilizing a secure application for data collection that will ensure that the data will be kept confidential and no internet protocol (IP) or email addresses will be associated with the data. Consent & Assent middle/high school students (13-17 years of age) - For the web-based learning and final evaluation of longitudinal study the user population ages will range between the ages of 13 and 17. This group will be either from camps or afterschool programs. This group will require signed parent consent of their participation and children will sign their assent if they agree to participate, but may withdraw at any time. It will include their email and their data collections forms/questions for the groups. Candice Adams can be reached at contact number (404) 939-7173 and email harri15@auburn.edu. Consent for Adults, AU grad; Web-learning environment usability study will have the safe guard that users will be university students older than 19 years of age and they will be assessing the usability of the application and will sign a consent form and are not considered a vulnerable population. Cheryl Seals can be reached at sealscd@auburn.edu. Adults, AU grad. students will be asked to voluntary and participate within the study. They can withdraw at anytime. The decision whether to participate or not to participate will not impact the student. Adults, AU grad. students will not be apart of the Professor's current class but could be a former student.

If using the Internet or other electronic means to collect data, what confidentiality or security precautions are in place to protect (or not collect) identifiable data? Include protections used during both the collection and transfer of data.

All students will be given a ramdom number as a Participant ID and only will be linked to the survey and not the participant. No other information will be collected. Students will be asked to destroy this number at the end of the study and not share it with other participants.

In regards to using SurveyMonkey, its added layer of SSL protection is protection. In regard to the project's security, all servers are kept in a locked facility under digital surveillance 24/7.

Additional information on SurveyMonkey can be found at http://www.sureymonkey.com/ .

16. BENEFITS.

a. **List all realistic direct benefits participants can expect by participating in this specific study.**
(Do not include "compensation" listed in #12d.) Check here if there are no direct benefits to participants. ☐

This study will indentify children age 13-17 as the subgroup that will benefit from accessing a web-based learning environment containing several course related to STEM education. Based on our research direction, our hope is that the particiipants of this work will have imporved understanding of STEM subjects and movitation to engage in STEM careers in the future.

Adults, AU graduate students will benefit from the study by getting a chance to conduct a usability study on a real system. Our hope is that they get to use the principles they have studied in order to evaluate an application.

b. **List all realistic benefits for the general population that may be generated from this study.**

We expect students (age: 13-17) will benefit from accessing websites that are designed specifically for them based on their needs and preferences as outline in our usability guidelines.

17. **PROTECTION OF DATA.**

a. **Data are collected:**

☐ **Anonymously with no direct or indirect coding, link, or awareness of who participated in the study (Skip to e)**

☐ **Confidentially, but without a link of participant's data to any identifying information (collected as "confidential" but recorded and analyzed as "anonymous") (Skip to e)**

☑ **Confidentially with collection and protection of linkages to identifiable information**

b. **If data are collected with identifiers or as coded or linked to identifying information, describe the identifiers collected and how they are linked to the participant's data.**

If data is collected from the same set of students then there is a possibility that we may be able to link participants based upon the participation code. Each participant will be instructed to enter a unique code in each questionnaire. Example Participation Code: SchoolInitials+RandomNumericCode. A numeric code will be given to all particpants to keep. If participant loose the code between studies, they will be given a new code. However, it is not a guarantee that a participant will choose to participate in all phases of the research.

c. **Justify your need to code participants' data or link the data with identifying information.**

d. **Describe how and where identifying data and/or code lists will be stored.** (Building, room number?) **Describe how the location where data is stored will be secured in your absence. For electronic data, describe security. If applicable, state specifically where any IRB-approved and participant-signed consent documents will be kept on campus for 3 years after the study ends.**

Data is stored electronically in SurveyMonkey. In regard to using SurveyMonkey, its added layer of SSL protection is protection. Inegard to the project's security, all servers are kept in a locked facility under digital surveillance 24/7.

e. **Describe how and where the data will be stored** (e.g., hard copy, audio cassette, electronic data, etc.), **and how the location where data is stored is separated from identifying data and will be secured in your absence. For electronic data, describe security**

Data is stored electronically in SurveyMonkey. In regard to using SurveyMonkey, its added layer of SSL protection is protection. Inegard to the project's security, all servers are kept in a locked facility under digital surveillance 24/7.

f. **Who will have access to participants' data?**
(*The faculty advisor should have full access and be able to produce the data in the case of a federal or institutional audit.*)

Project leaders Adams and Seals.

g. **When is the latest date that identifying information or links will be retained and how will that information or links be destroyed?**
(Check here if only anonymous data will be retained ☐)

Data will not be kept no more than 3 years after data has been analyzed and reported/published.

APPENDIX D

EXPERT CONSENT FORM

AUBURN UNIVERSITY
SAMUEL GINN COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMED CONSENT
for a Research Study entitled
"A Collaborative, Adaptive-Based Approach to Informal E-Learning Technology Design"

You are invited to participate in a research study to help us understand and identify user design guidelines for **Collaborative, Adaptive-Based Learning Environment** that will be used to support STEM education. Participants will explore a web-based course management system and will be asked to provide opinions about this system based upon the 10 usability heuristics. The study is being conducted by Candice Adams, PhD Candidate at Auburn University, under the direction of Dr. Cheryl Seals, Associate Professor in the Auburn University Department of Computer Science and Software Engineering. You are invited to participate because you are 19 or older and a Computer Science graduate student. You must also have experience with the 10 usability heuristics. Here is a link to the 10 usability heuristics provided by Jakob Nielsen: 10 Heuristics.

What will be involved if you participate? We are interested in Computer Science Graduate students who are 19 years or older. If you decide to participate in this research study, you will be asked to review and explore a web-based course management system. The course management system allows students to view material on a particular subject as well as take quizzes on that particular material. You will be asked to present and discussion your findings in a group setting. Your total time commitment will be approximately 1-2 hours.

Are there any risks or discomforts?
There are no anticipated risks associated with participating in this study.

Are there any benefits to you or others?
If you participates in this study, you can expect to have improved understanding of subject in the STEM field such as Computer Science and Chemistry. We cannot promise you that he/she will receive any or all of the benefits described.

Are there any costs?
If you decide to participate, you will not be responsible for any costs associated with participating.

If you change your mind about participation, you can be withdrawn from the study at any time. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your relations with Auburn University, the Department of Computer Science and Software Engineering.

Your privacy will be protected. Any information obtained in connection with this study will remain confidential. The data collected will be protected by not collecting any identifiable information such as your name and address. Information obtained through your participation may be published in professional journals and presented at professional meetings and conferences. All information linking you to a particular questionnaire will be destroyed within 1 year after the research study. Only final cumulative results will be reported.

If you have questions about this study, please ask them now or contact Candice Adams at candice.adams@auburn.edu or (404)-939-7173. A copy of this document will be given to you to keep.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334)-844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

1

Participants Initials______

Signatures:

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______________________	______________________	______________
Participants Signature	Printed Name	Date
______________________	______________________	______________
Investigator	Printed Name	Date
______________________	______________________	______________
Co-Investigator	Printed Name	Date

Participants Initials______

APPENDIX E

PARENTAL CONSENT

LETTERHEAD

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

PARENTAL PERMISSION/CONSENT
for a Research Study entitled
"A Collaborative, Adaptive-Based Approach to Informal E-Learning Technology Design"

Your son or daughter is invited to participate in a research study to help us understand and identify user design guidelines for **Collaborative, Adaptive-Based Learning Environment** (ages 13-17). Participants will explore a web-based course management system and will be asked to provide opinions about this system. The course management system allows students to view material on a particular subject as well as take quizzes on that particular material. The study is being conducted by Candice Adams, PhD Candidate at Auburn University, under the direction of Dr. Cheryl Seals, Associate Professor in the Auburn University Department of Computer Science and Software Engineering. Your son/daughter is invited to participate because he/she is a teenager aged 13-17 or will be in this age range on the day of the study. Since he/she is age 19 or younger, we must have your permission to include him/her in the study.

What will be involved if he or she participates? We are interested in teenagers age 13-17. If you decide to allow him or her to participate in this research study, he or she will be asked to review to review and explore a web-based course management system. A survey will be conducted afterwards to capture demographic information (e.g. age, sex, race/ethnicity), computer experience, and opinions about the system. Your son/daughter's total time commitment will be approximately 1-2 hours.

Are there any risks or discomforts?
There are no anticipated risks associated with participating in this study.

Are there any benefits to your son/daughter or others?
If he/she participates in this study, he/she can expect to have improved understanding of subject in the STEM field such as Computer Science and Chemistry. We cannot promise you that he/she will receive any or all of the benefits described.

Will you or your son/daughter receive compensation for participating?
There will be no compensation for participating.

Are there any costs?
If you decide to allow your son/daughter to participate, you/he/she will not be responsible for any costs associated with participating.

If you (or your son/daughter) change your mind about his/her participation, he/she can be withdrawn from the study at any time. Your son's/daughter's participation is completely voluntary. If you choose to withdraw him/her, your son's/daughter's confidential data can be withdrawn as long as it is identifiable. Your decision about whether or not to allow your son/daughter to participate or to stop participating will not jeopardize your or his/her future relations with Auburn University, the Department of Computer Science and Software Engineering.

Your son's/daughter's privacy will be protected. Any information obtained in connection with this study will remain confidential. The confidential data collected will be protected by not collecting any identifiable information such as his/her name and address. Information obtained through his/her participation may be published in professional journals and presented at professional meetings and conferences.

If you (or your son/daughter) have questions about this study, please ask them now or contact Candice Adams at candice.adams@auburn.edu or (404)-939-7173. A copy of this document will be given to you to keep. All information will be kept confidential.

If you have questions about your son's/daughter's rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334)-844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

1

Parent/Guardian Initials______

Signatures:

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER YOU WISH FOR YOUR SON OR DAUGHTER TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO ALLOW HIM OR HER TO PARTICIPATE.

Parent/Guardian Signature	Printed Name	Date
Child	Printed Name	Date
Investigator	Printed Name	Date
Co-Investigator	Printed Name	Date

Minor's name: ____

Office use only:

Participant ID: ____________________

2

Parent/Guardian Initials______

APPENDIX F

RECRUITMENT SCRIPT

Participants Ages: 13-17

Appendix B

RECRUITMENT SCRIPTS

For the Study entitled:
"A Collaborative, Adaptive-Based Approach to Informal E-Learning Technology Design"

This will be used for all participants that are age 13-17.

I am Candice Adams, a PhD Candidate in the Department of Computer Science and Software Engineering at Auburn University. I would like to invite you to participate in my research study to help us understand how to approach the design of adaptive –based eLearning Technology Design (ages 13-17). You may participate if you are 13-17 years old and will be in this age range when you participate in the study. Please do not participate if you are not 13-17 years old and will be in this age range when you participate in the study.

As a participant, you will be asked to visit and interact within an E-Learning environment and provide opinions about the environment. It is a web-based environemnt so you will not need to install any software. Your time commitment will be apprioximatley 1-2 hours.

The risks associated with participating in this study are minimal. To minimize the possibility of risk, you will be assigned a random code to protect your confidentiality. If you participate in this study, you can expect to improve your understanding in a variety of STEM subject areas (i.e. Chemistry & Computer Science [Programming]). We cannot promise you that you will receive any or all of the benefits described. There are no costs associated with participating.

If you would like to participate in this research study, email me at candice.adams@auburn.edu. If you have questions, please email me or contact me at 334-421-9030 or you may contact my advisor, Dr. Cheryl Seals, at (334) 844-6319 or by e-mail at sealscd@auburn.edu.

Do you have any questions now? If you have questions later, all of my contact information as well as my advisor information will be in the flyer provided.

APPENDIX G

RECRUITMENT SCRIPT

Expert Participants

Dear Computer Science Graduate Students,

I am Candice Adams, a PhD Candidate in the Department of Computer Science and Software Engineering at Auburn University. I would like to invite you to participate in my research study to "A Collaborative, Adaptive-Based Approach to Informal E-Learning Technology Design"

You may participate if you are age 19 or older and a Computer Science graduate student. Participants will be asked to present and discuss finding. The total time commitment for discussion will be 90 minutes. The session will take place via Skype.

The risks associated with participating in this study are minimal. To minimize the possibility of risk, you will be assigned a pseudonym to protect your confidentiality and for the purposes of manuscripts and presentations of research.

If you would like to know more information about this study, an information letter and surveys are available at this link: [LinkWillBeProvidedHERE]. By clicking the link you are indicating interest to participate in this study. If you decide to participate after reading the information letter, please contact Candice Adams (candice.adams@auburn.edu)

If you have any questions, please contact me, Candice Adams, candice.adams@auburn.edu or at 404-939-7173.

Thank you for your consideration,
Candice Adams

APPENDIX H (27 pages)

PRE-QUESTIONNAIRE – STUDENT DEMOGRAPHICS/WITH RESULTS

*Information stored in a separate document.

APPENDIX I (28 pages)

Post-Questionnaire – Student's comparative evaluation

of the ChemiNet and COLORS applications.

*Information stored in a separate document.

APPENDIX J (14 pages)

Expert Evaluation of the ChemiNet Application

*Information stored in a separate document.

APPENDIX K (14 pages)

Expert Evaluation of the COLORS Application

*Information stored in a separate document.

APPENDIX L (80 pages)

Expert ChemiNet Statistical Results

*Information stored in a separate document.

APPENDIX M (80 pages)

Expert COLORS Statistical Results

*Information stored in a separate document.

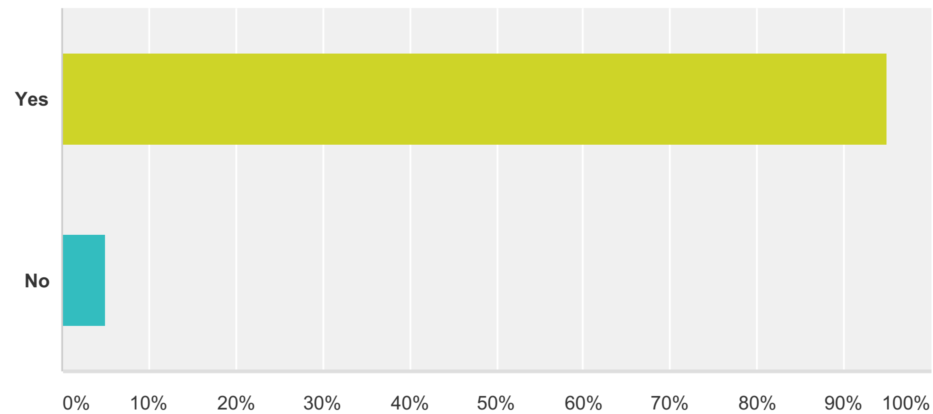
APPENDIX N (3 pages)

***Comparison of COLORS and ChemiNet (Expert Evaluation)/Expert Raw Data**

APPENDIX H (27 pages)

Q1 Do you agree to participate in this study with your parent (s) consent?

Answered: 20 Skipped: 0



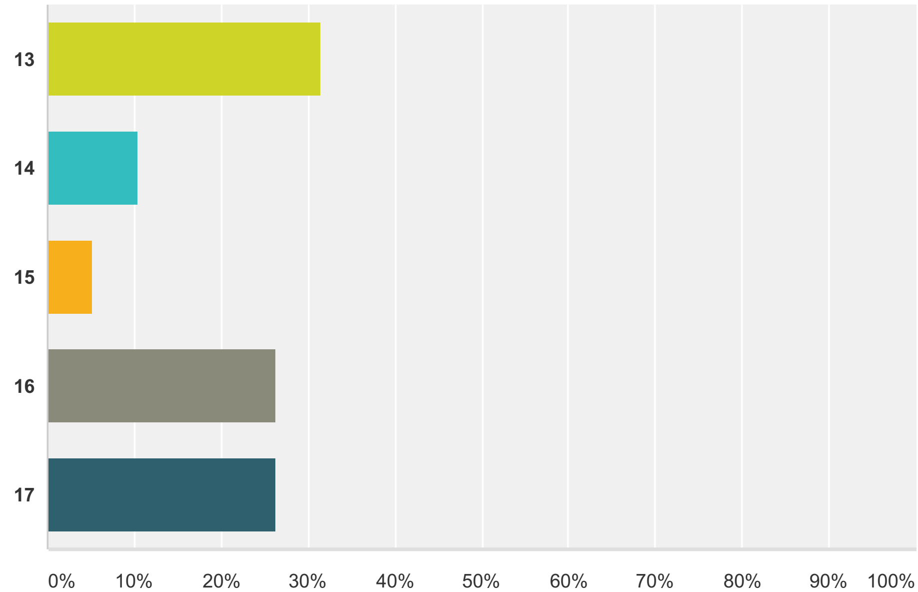
Answer Choices	Responses	
Yes	**95.00%**	19
No	**5.00%**	1
Total		**20**

Q2 Participant ID (SchoolInitials + Random Code which will be provided):

Answered: 19 Skipped: 1

Q3 What is your age?

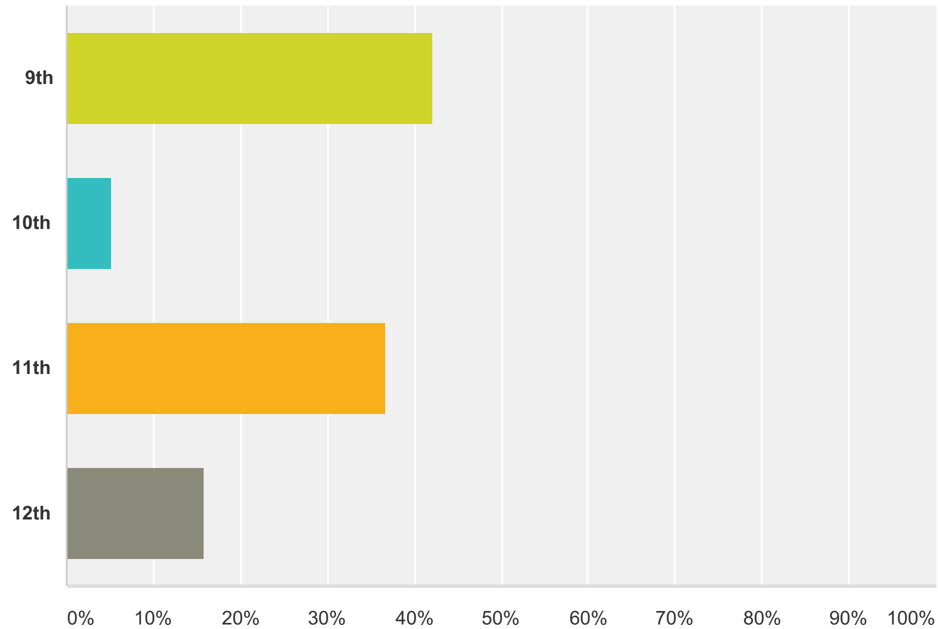
Answered: 19 Skipped: 1



Answer Choices	Responses	
13	**31.58%**	6
14	**10.53%**	2
15	**5.26%**	1
16	**26.32%**	5
17	**26.32%**	5
Total		**19**

Q4 What is your Grade Level?

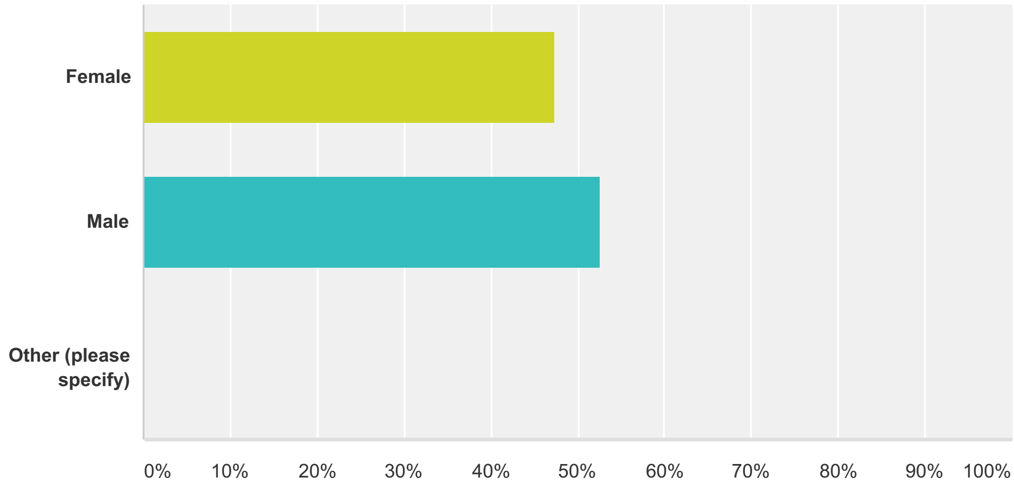
Answered: 19 Skipped: 1



Answer Choices	Responses	
9th	**42.11%**	8
10th	**5.26%**	1
11th	**36.84%**	7
12th	**15.79%**	3
Total		**19**

Q5 What is your gender?

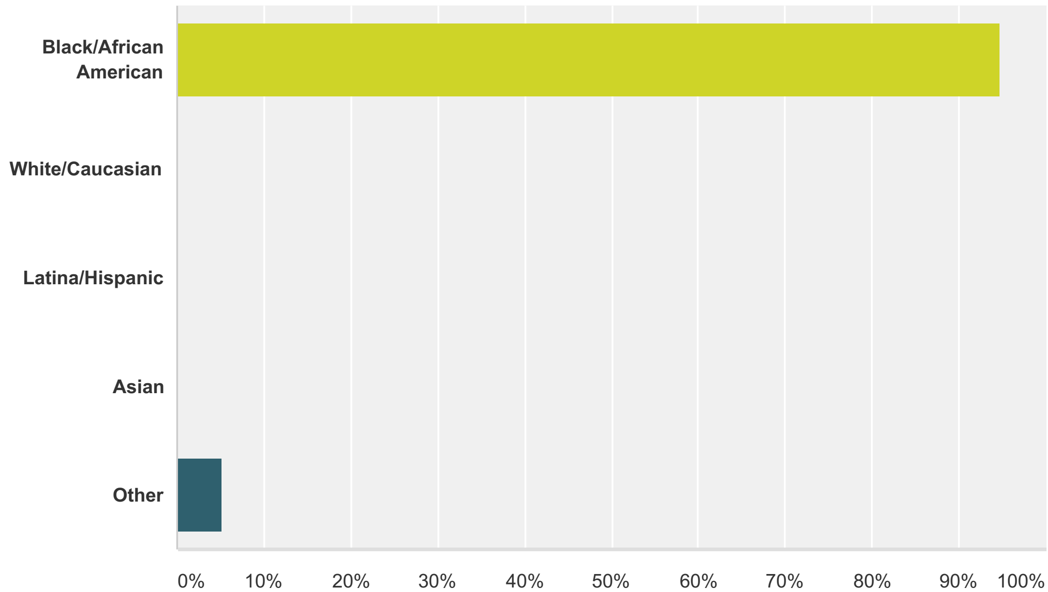
Answered: 19 Skipped: 1



Answer Choices	Responses	
Female	**47.37%**	9
Male	**52.63%**	10
Other (please specify)	**0.00%**	0
Total		**19**

Q6 What is your race?

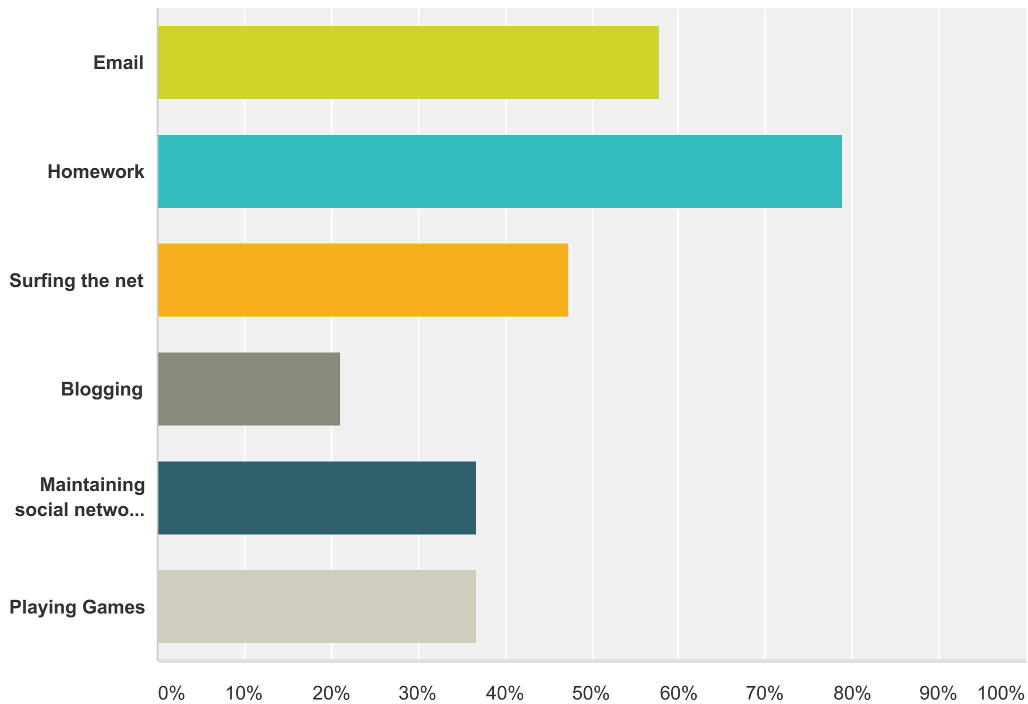
Answered: 19 Skipped: 1



Answer Choices	Responses	
Black/African American	**94.74%**	18
White/Caucasian	**0.00%**	0
Latina/Hispanic	**0.00%**	0
Asian	**0.00%**	0
Other	**5.26%**	1
Total		**19**

Q7 What do you normally use a computer for? (Select all that apply)

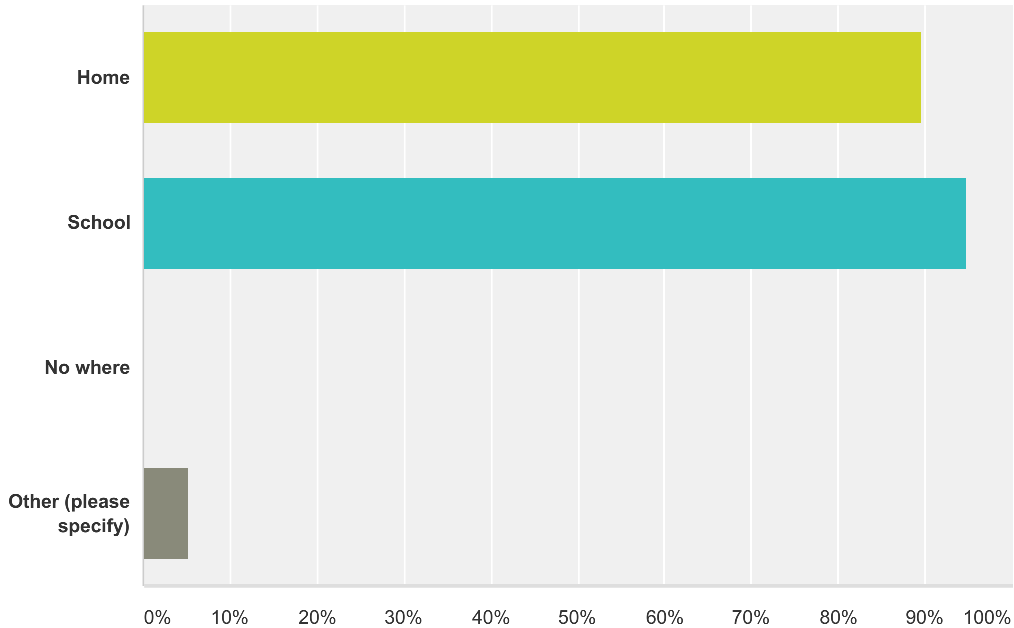
Answered: 19 Skipped: 1



Answer Choices	Responses	
Email	**57.89%**	11
Homework	**78.95%**	15
Surfing the net	**47.37%**	9
Blogging	**21.05%**	4
Maintaining social network like Facebook, twitter etc	**36.84%**	7
Playing Games	**36.84%**	7
Total Respondents: 19		

Q8 Where have you used a computer before?

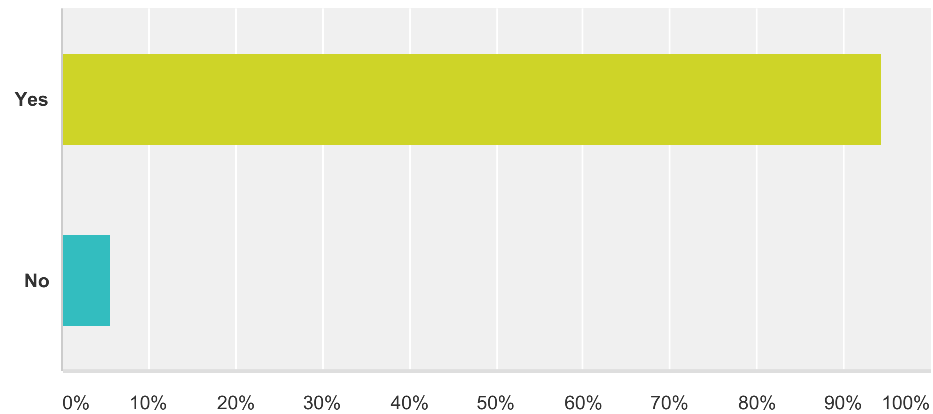
Answered: 19 Skipped: 1



Answer Choices	Responses	
Home	**89.47%**	17
School	**94.74%**	18
No where	**0.00%**	0
Other (please specify)	**5.26%**	1
Total Respondents: 19		

Q9 Do you feel that online material can enhance traditional classroom learning?

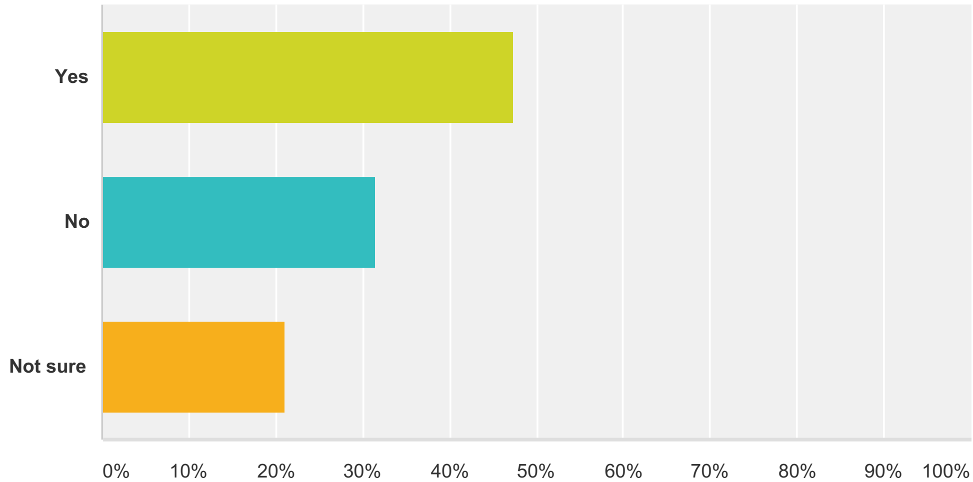
Answered: 18 Skipped: 2



Answer Choices	Responses	
Yes	**94.44%**	17
No	**5.56%**	1
Total		**18**

Q10 Do you like chemistry?

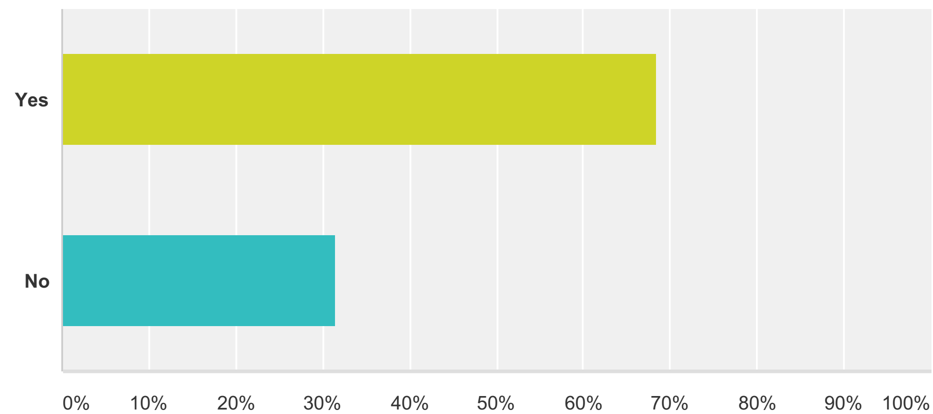
Answered: 19 Skipped: 1



Answer Choices	Responses	
Yes	**47.37%**	9
No	**31.58%**	6
Not sure	**21.05%**	4
Total		**19**

Q11 Are you interested in a STEM (Science, Technology, Engineering and Math) career choice?

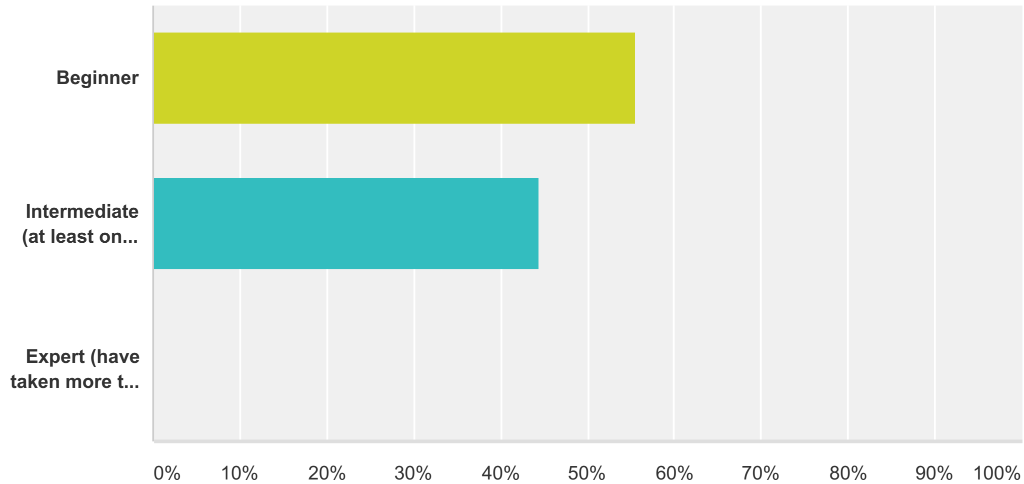
Answered: 19 Skipped: 1



Answer Choices	Responses	
Yes	**68.42%**	13
No	**31.58%**	6
Total		**19**

Q12 Select your level of proficiency with Chemistry...

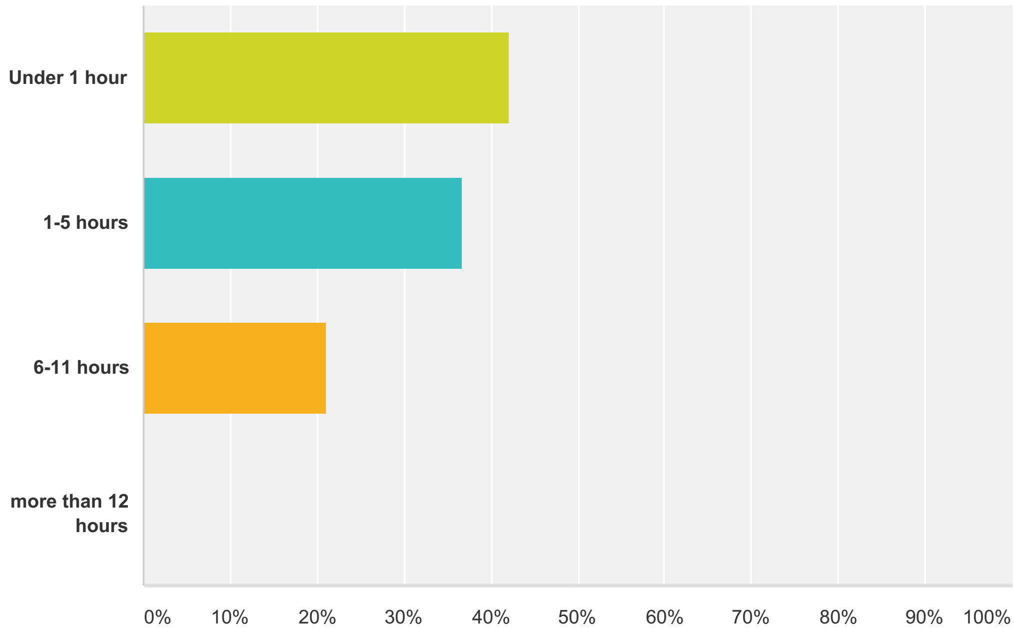
Answered: 18 Skipped: 2



Answer Choices	Responses	
Beginner	**55.56%**	10
Intermediate (at least once course in Chemistry)	**44.44%**	8
Expert (have taken more than one course in Chemistry)	**0.00%**	0
Total		**18**

Q13 How often do you use a computer a week for fun/play?

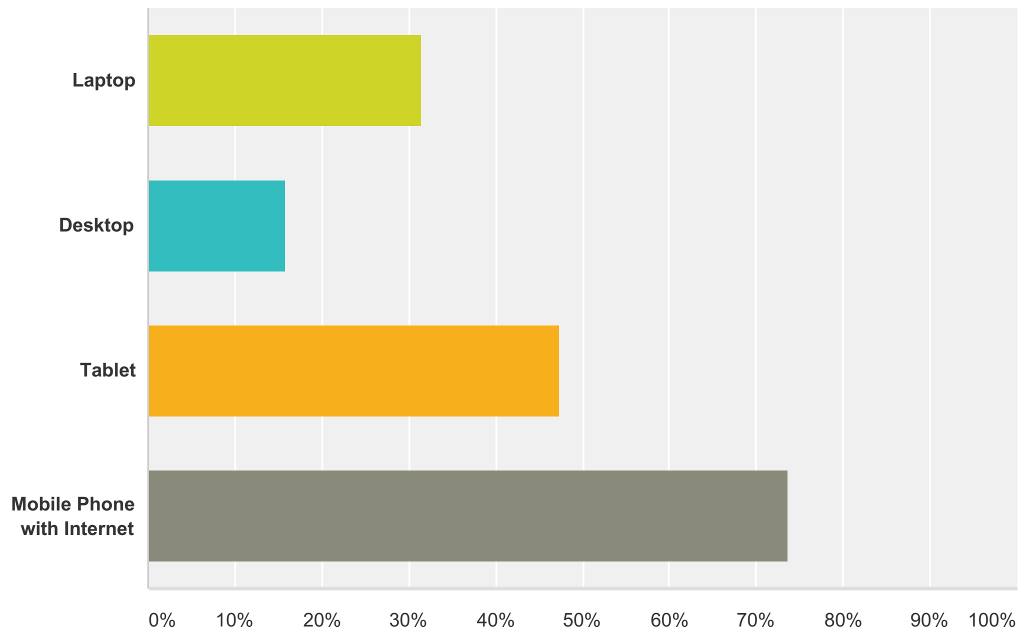
Answered: 19 Skipped: 1



Answer Choices	Responses	
Under 1 hour	**42.11%**	8
1-5 hours	**36.84%**	7
6-11 hours	**21.05%**	4
more than 12 hours	**0.00%**	0
Total		**19**

Q14 What type of devices do you use on a regular basis to access the Internet?

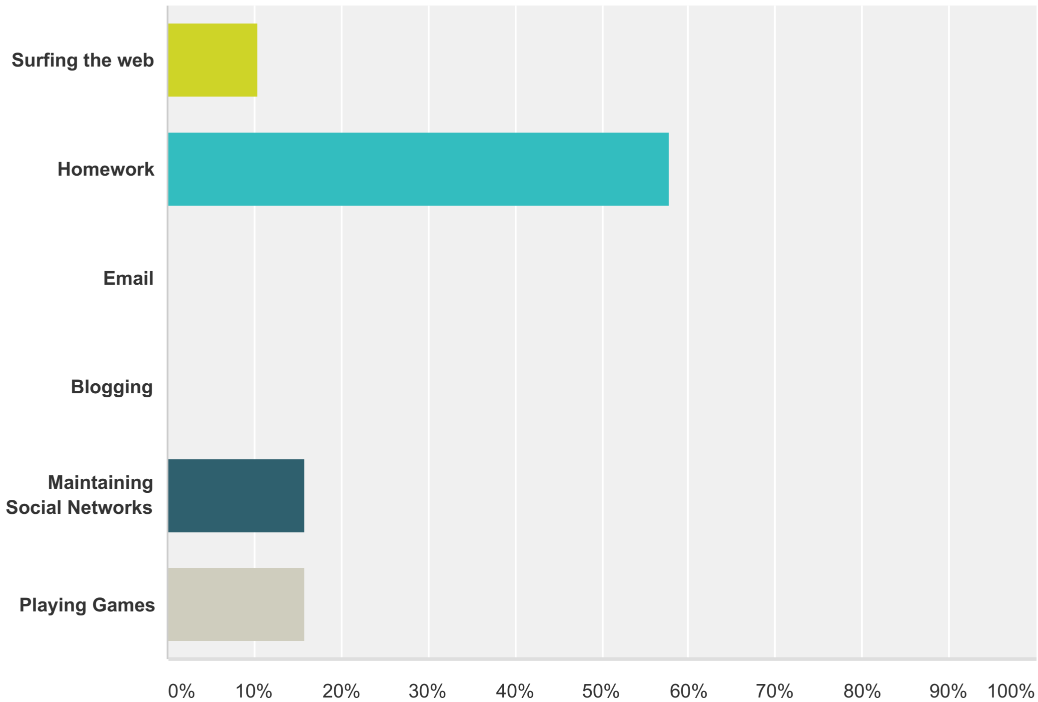
Answered: 19 Skipped: 1



Answer Choices	Responses	
Laptop	**31.58%**	6
Desktop	**15.79%**	3
Tablet	**47.37%**	9
Mobile Phone with Internet	**73.68%**	14
Total Respondents: 19		

Q15 What do you normally use a computer for?

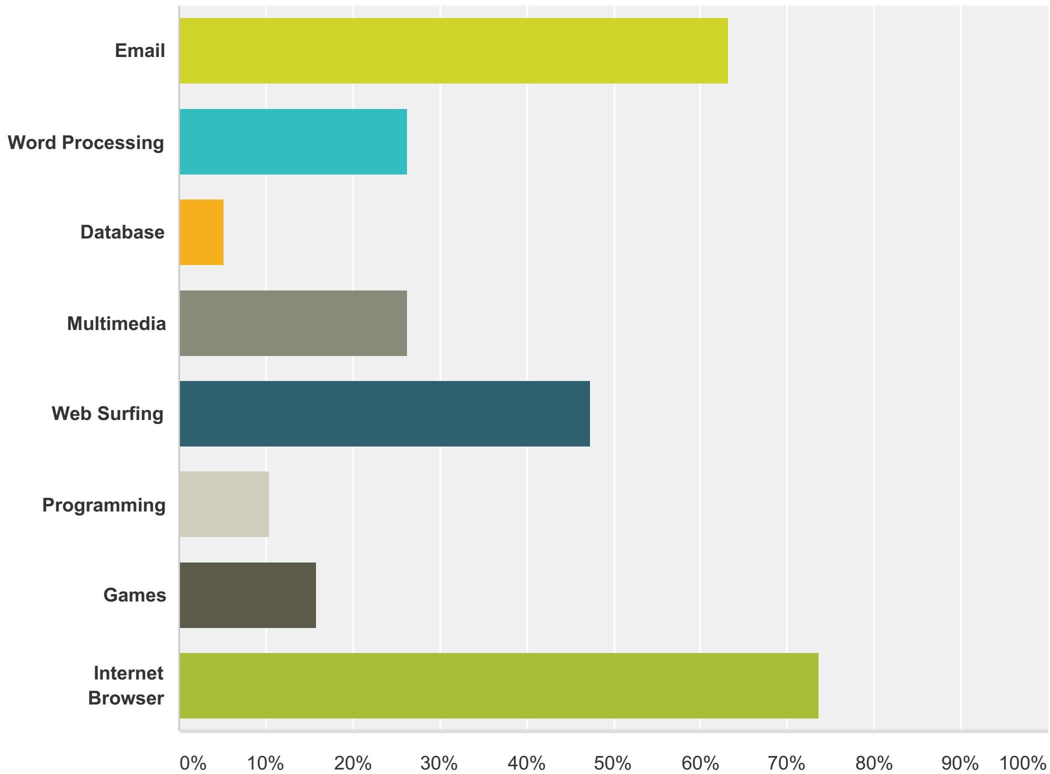
Answered: 19 Skipped: 1



Answer Choices	Responses	
Surfing the web	**10.53%**	2
Homework	**57.89%**	11
Email	**0.00%**	0
Blogging	**0.00%**	0
Maintaining Social Networks	**15.79%**	3
Playing Games	**15.79%**	3
Total		**19**

Q16 What type of application(s) you use on a regular basis?

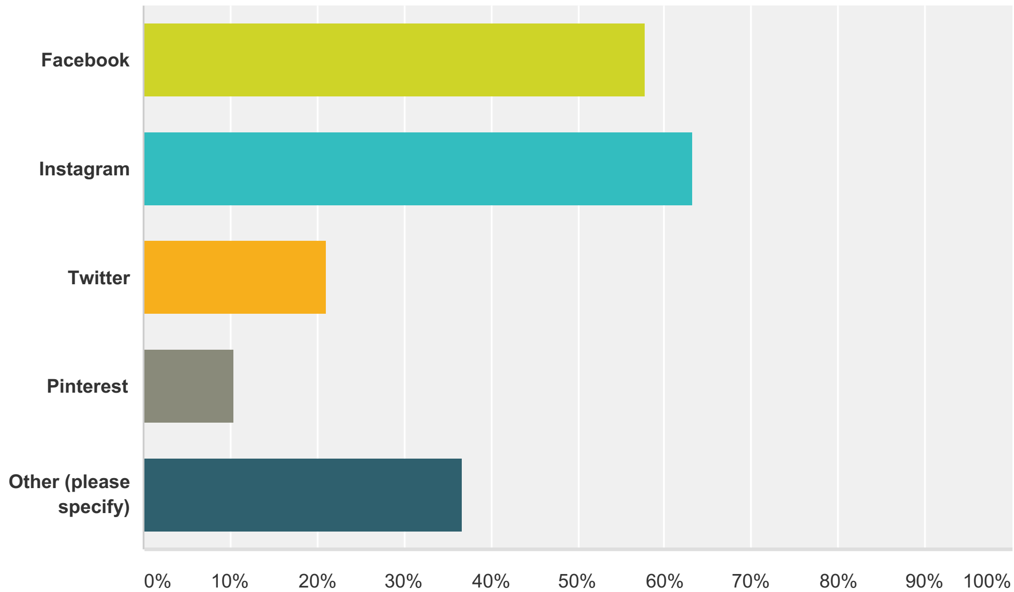
Answered: 19 Skipped: 1



Answer Choices	Responses	
Email	**63.16%**	12
Word Processing	**26.32%**	5
Database	**5.26%**	1
Multimedia	**26.32%**	5
Web Surfing	**47.37%**	9
Programming	**10.53%**	2
Games	**15.79%**	3
Internet Browser	**73.68%**	14
Total Respondents: 19		

Q17 Do you maintain any Social Media sites? If so, which ones?

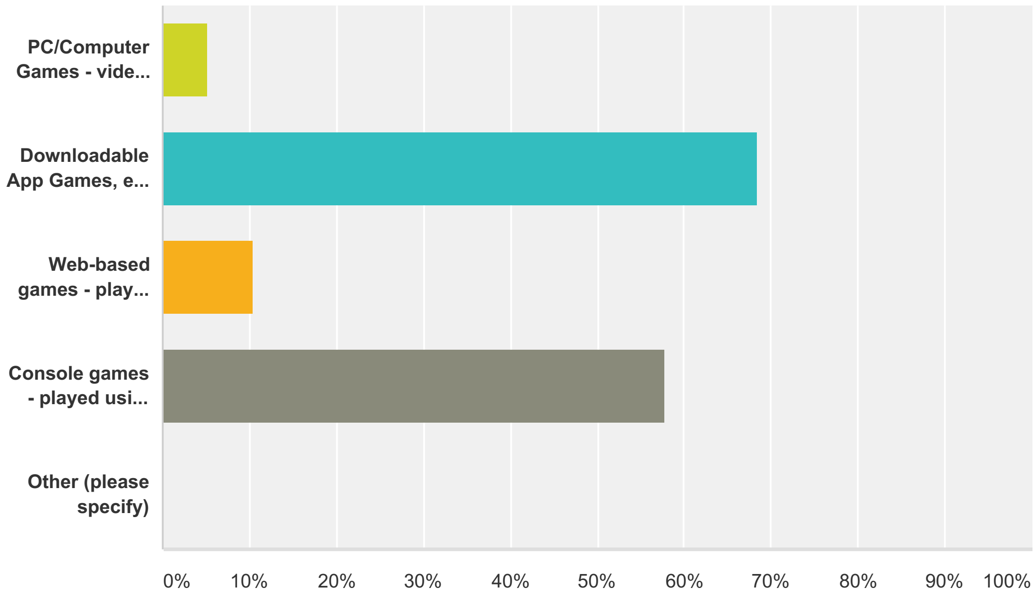
Answered: 19 Skipped: 1



Answer Choices	Responses	
Facebook	**57.89%**	11
Instagram	**63.16%**	12
Twitter	**21.05%**	4
Pinterest	**10.53%**	2
Other (please specify)	**36.84%**	7
Total Respondents: 19		

Q18 If you play games, which type of games do you play?

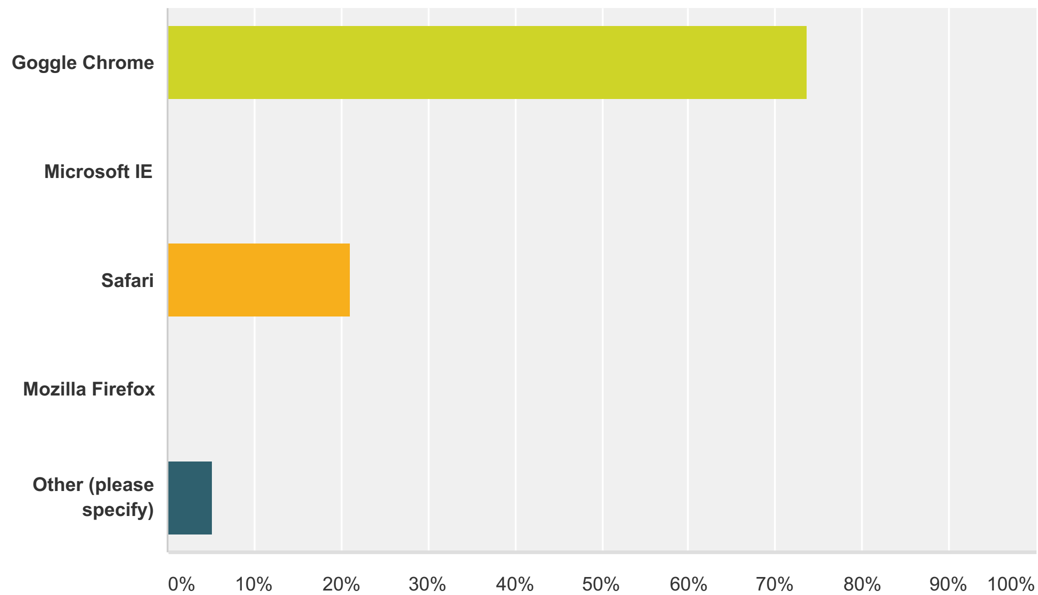
Answered: 19 Skipped: 1



Answer Choices	Responses	
PC/Computer Games - video games played on a personal computer	**5.26%**	1
Downloadable App Games, e.g. Candy Crush, Temple Run	**68.42%**	13
Web-based games - played through the web browser	**10.53%**	2
Console games - played using a console such as Playstation 4 or XBox One	**57.89%**	11
Other (please specify)	**0.00%**	0
Total Respondents: 19		

Q19 What type of web browser do you use frequently?

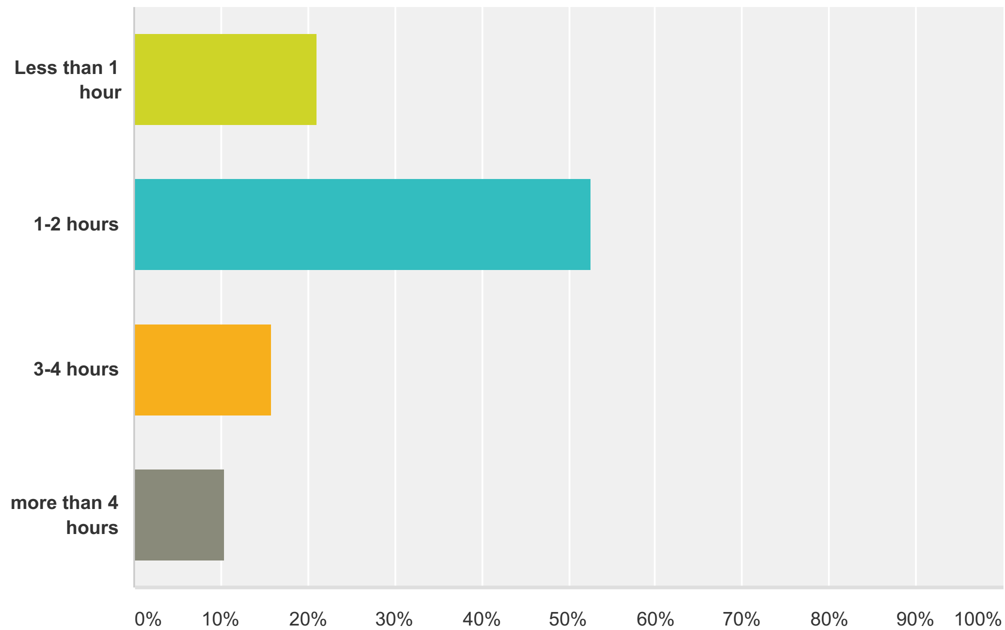
Answered: 19 Skipped: 1



Answer Choices	Responses	
Goggle Chrome	**73.68%**	14
Microsoft IE	**0.00%**	0
Safari	**21.05%**	4
Mozilla Firefox	**0.00%**	0
Other (please specify)	**5.26%**	1
Total		**19**

Q20 On average, how many hours a day do you spend online using the Internet for doing school work?

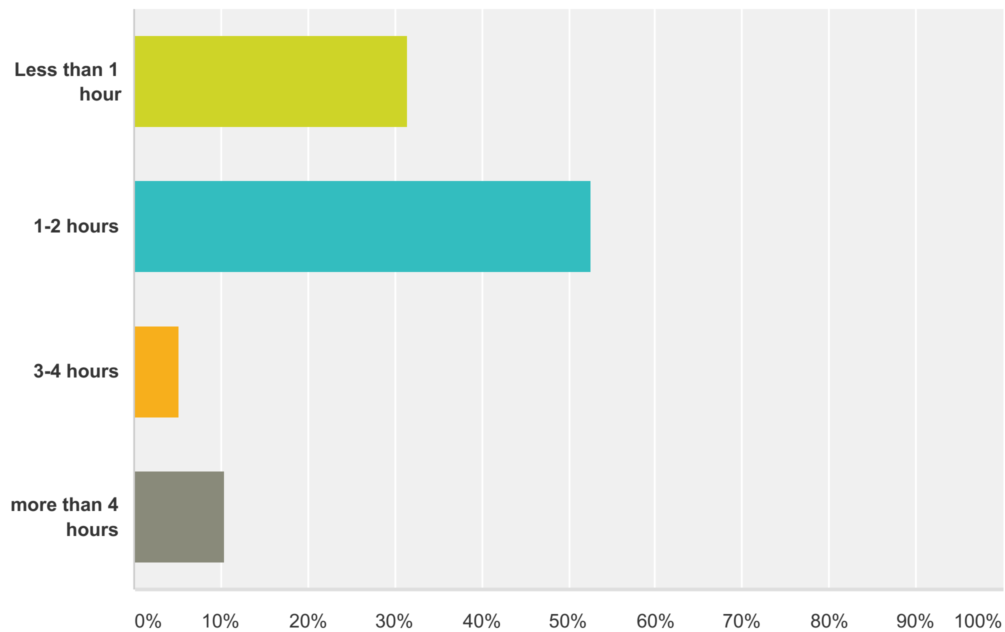
Answered: 19 Skipped: 1



Answer Choices	Responses	
Less than 1 hour	**21.05%**	4
1-2 hours	**52.63%**	10
3-4 hours	**15.79%**	3
more than 4 hours	**10.53%**	2
Total		**19**

Q21 On average, how many hours a day do you spend online using the Internet doing school-related tasks?

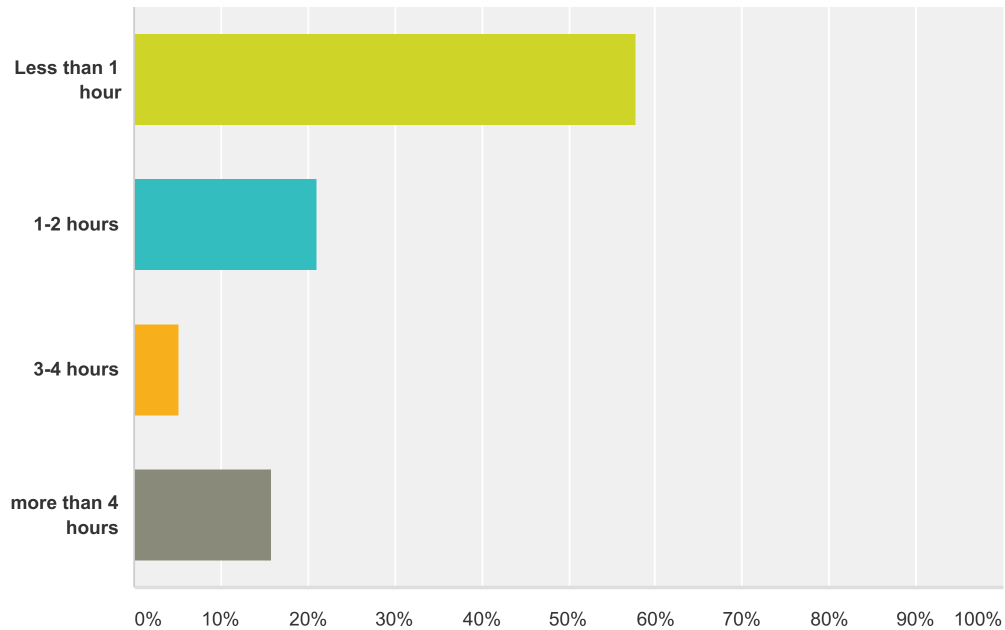
Answered: 19 Skipped: 1



Answer Choices	Responses	
Less than 1 hour	**31.58%**	6
1-2 hours	**52.63%**	10
3-4 hours	**5.26%**	1
more than 4 hours	**10.53%**	2
Total		**19**

Q22 On an average, how many hours a day do you spend online using the Internet playing video games

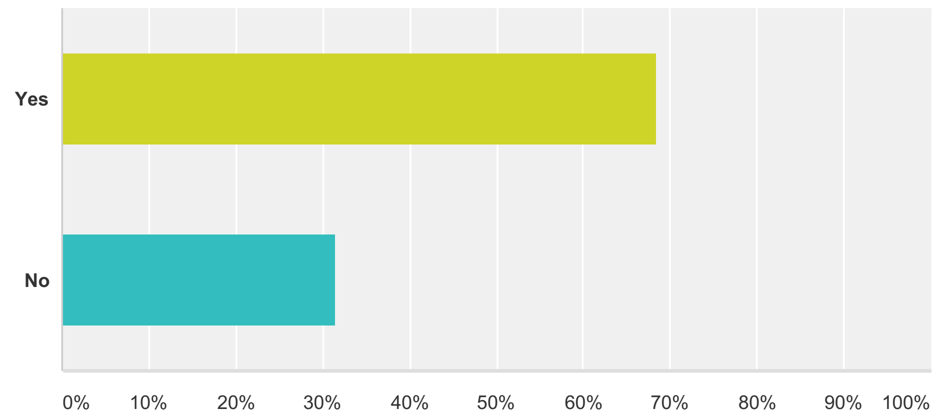
Answered: 19 Skipped: 1



Answer Choices	Responses	
Less than 1 hour	**57.89%**	11
1-2 hours	**21.05%**	4
3-4 hours	**5.26%**	1
more than 4 hours	**15.79%**	3
Total		**19**

Q23 Do you have prior experience using an online learning environment?

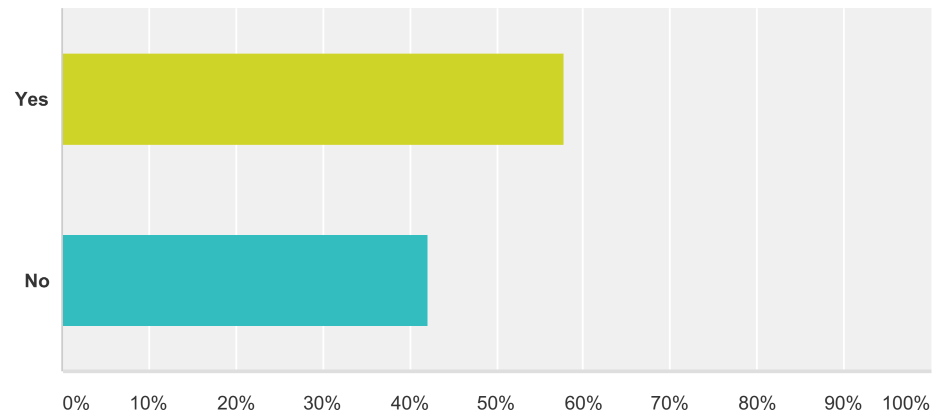
Answered: 19 Skipped: 1



Answer Choices	Responses	
Yes	**68.42%**	13
No	**31.58%**	6
Total		**19**

Q24 Have you taken any courses over the Internet?

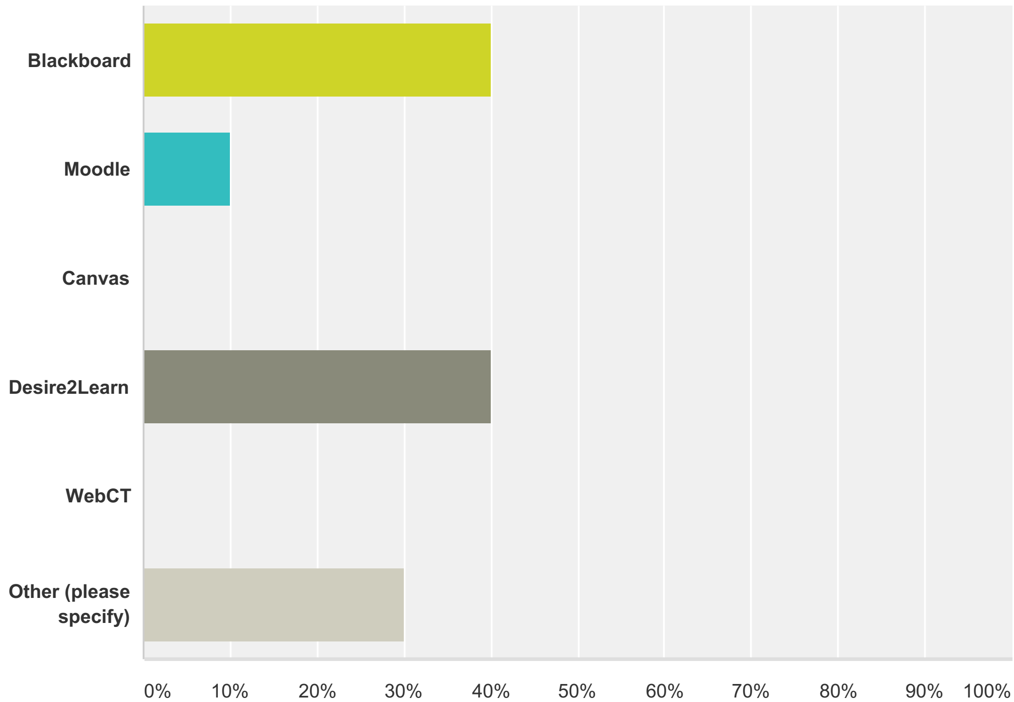
Answered: 19 Skipped: 1



Answer Choices	Responses	
Yes	**57.89%**	11
No	**42.11%**	8
Total		**19**

Q25 Have you used one of the following?

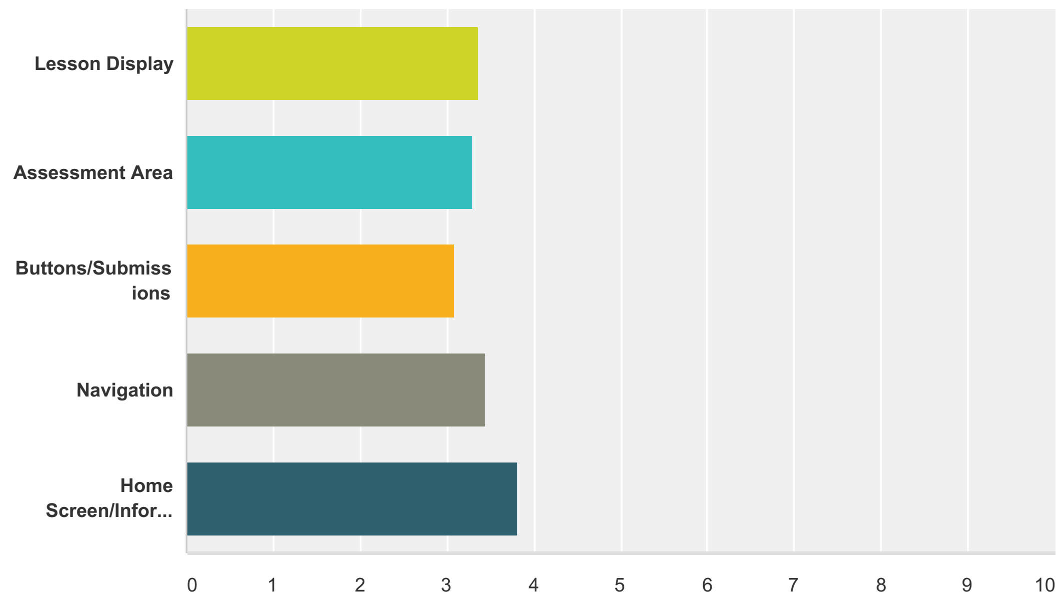
Answered: 10 Skipped: 10



Answer Choices	Responses	
Blackboard	**40.00%**	4
Moodle	**10.00%**	1
Canvas	**0.00%**	0
Desire2Learn	**40.00%**	4
WebCT	**0.00%**	0
Other (please specify)	**30.00%**	3
Total Respondents: 10		

Q26 Please rate your overall satisfaction with the online environment you have used in the past..

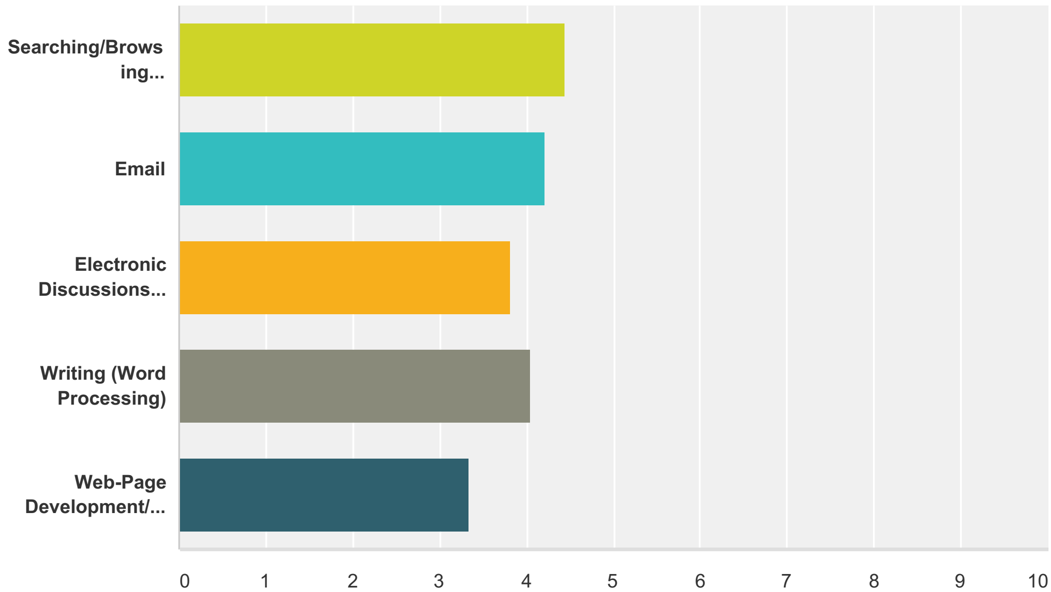
Answered: 11 Skipped: 9



	Poor	Below Average	Average	Above Average	Excellent	Total	Weighted Average
Lesson Display	**0.00%** 0	**9.09%** 1	**54.55%** 6	**27.27%** 3	**9.09%** 1	11	3.36
Assessment Area	**0.00%** 0	**10.00%** 1	**50.00%** 5	**40.00%** 4	**0.00%** 0	10	3.30
Buttons/Submissions	**9.09%** 1	**9.09%** 1	**45.45%** 5	**36.36%** 4	**0.00%** 0	11	3.09
Navigation	**0.00%** 0	**27.27%** 3	**27.27%** 3	**18.18%** 2	**27.27%** 3	11	3.45
Home Screen/Information Provided	**0.00%** 0	**9.09%** 1	**18.18%** 2	**54.55%** 6	**18.18%** 2	11	3.82

Q27 Please rate your competency...

Answered: 18 Skipped: 2



	Poor	Below Average	Average	Above Average	Excellent	Total	Weighted Average
Searching/Browsing Web/Internet	**0.00%** 0	**0.00%** 0	**16.67%** 3	**22.22%** 4	**61.11%** 11	18	4.44
Email	**0.00%** 0	**5.56%** 1	**11.11%** 2	**38.89%** 7	**44.44%** 8	18	4.22
Electronic Discussions (e.g. Facebook, LinkedIn, Twitter)	**5.88%** 1	**17.65%** 3	**11.76%** 2	**17.65%** 3	**47.06%** 8	17	3.82
Writing (Word Processing)	**0.00%** 0	**5.56%** 1	**27.78%** 5	**22.22%** 4	**44.44%** 8	18	4.06
Web-Page Development/Computer Programming	**11.11%** 2	**11.11%** 2	**38.89%** 7	**11.11%** 2	**27.78%** 5	18	3.33

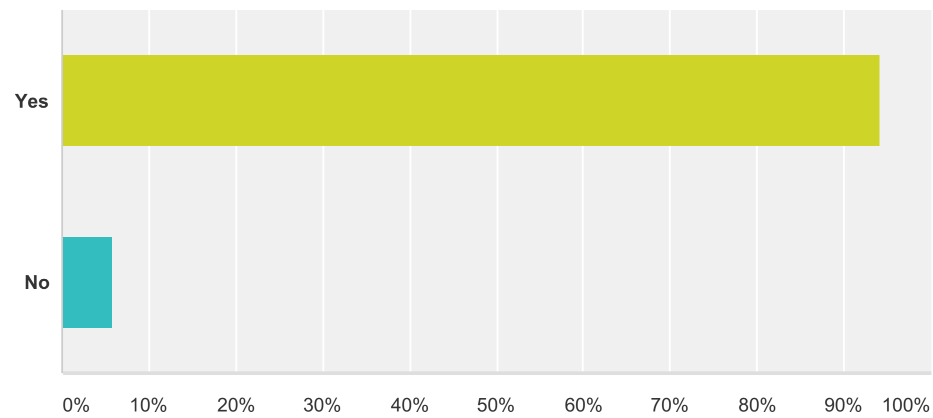
APPENDIX I (28 pages)

Q1 Participant ID (Enter same ID from pre-survey):

Answered: 17 Skipped: 0

Q2 Now that you have reviewed two online web-based applications, do you feel that online materials can enhance traditional classroom material?

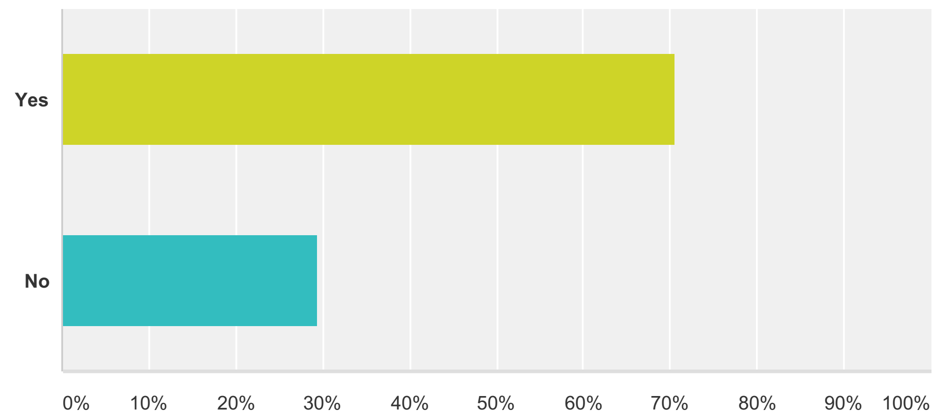
Answered: 17 Skipped: 0



Answer Choices	Responses	
Yes	**94.12%**	16
No	**5.88%**	1
Total		**17**

Q3 Did you review the COLORS (http://colorsonline.azurewebsites.net/) application?

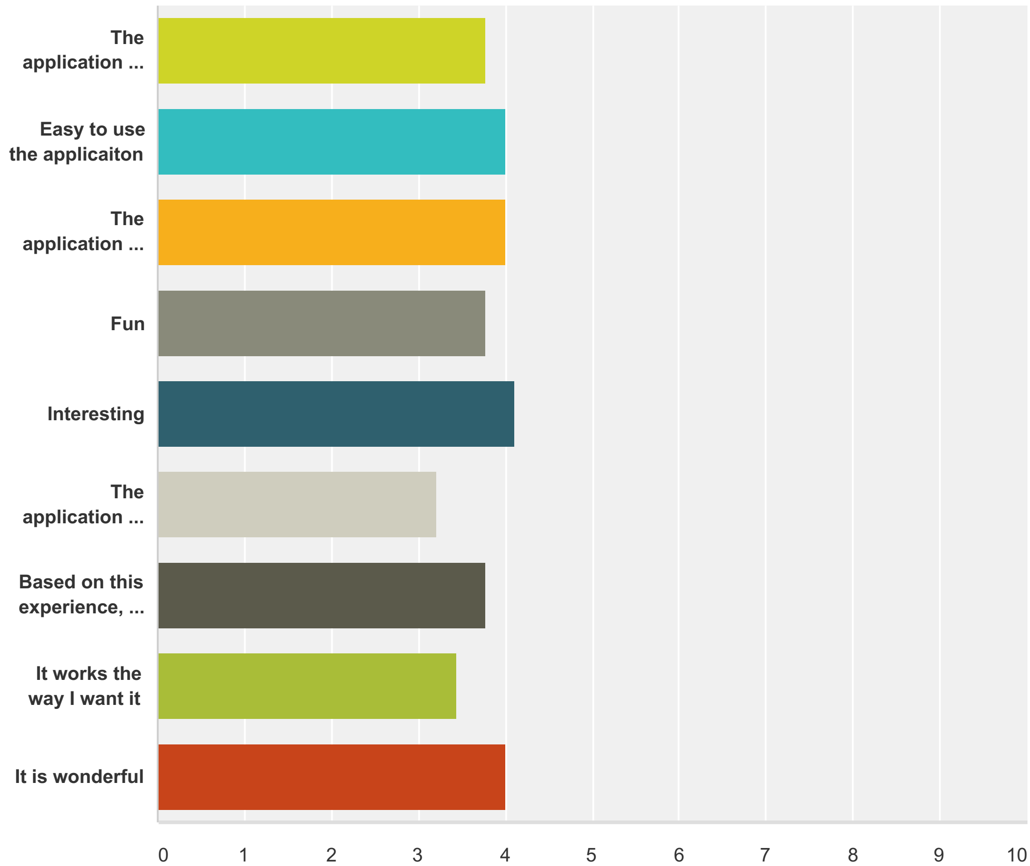
Answered: 17 Skipped: 0



Answer Choices	Responses	
Yes	**70.59%**	12
No	**29.41%**	5
Total		**17**

Q4 What is the overall reaction to the COLORS Application?

Answered: 9 Skipped: 8

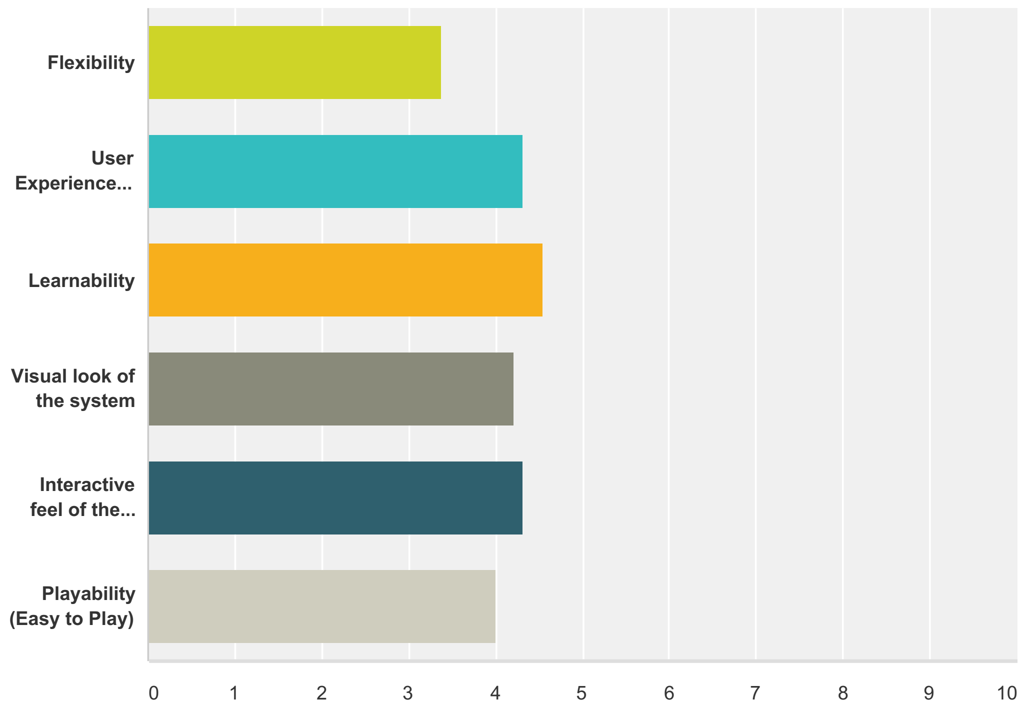


	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Total	Weighted Average
The application is attractive	**22.22%** 2	**55.56%** 5	**11.11%** 1	**0.00%** 0	**11.11%** 1	9	3.78
Easy to use the applicaiton	**44.44%** 4	**33.33%** 3	**11.11%** 1	**0.00%** 0	**11.11%** 1	9	4.00
The application is easy to learn to use	**44.44%** 4	**33.33%** 3	**11.11%** 1	**0.00%** 0	**11.11%** 1	9	4.00
Fun	**22.22%** 2	**55.56%** 5	**11.11%** 1	**0.00%** 0	**11.11%** 1	9	3.78
Interesting	**55.56%** 5	**22.22%** 2	**11.11%** 1	**0.00%** 0	**11.11%** 1	9	4.11
The application is flexible to play	**11.11%** 1	**22.22%** 2	**55.56%** 5	**0.00%** 0	**11.11%** 1	9	3.22
Based on this experience, I will use this site if available	**33.33%** 3	**33.33%** 3	**22.22%** 2	**0.00%** 0	**11.11%** 1	9	3.78
It works the way I want it	**11.11%** 1	**44.44%** 4	**33.33%** 3	**0.00%** 0	**11.11%** 1	9	3.44

It is wonderful	**55.56%** 5	**11.11%** 1	**22.22%** 2	**0.00%** 0	**11.11%** 1	9	4.00

Q5 Please rate COLORS with respect to following aspects:

Answered: 9 Skipped: 8



	Very High	High	Moderate	Low	Very Low	Total	Weighted Average
Flexibility	**0.00%** 0	**62.50%** 5	**25.00%** 2	**0.00%** 0	**12.50%** 1	8	3.38
User Experience (Good feeling about the system)	**44.44%** 4	**44.44%** 4	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	4.33
Learnability	**55.56%** 5	**44.44%** 4	**0.00%** 0	**0.00%** 0	**0.00%** 0	9	4.56
Visual look of the system	**33.33%** 3	**55.56%** 5	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	4.22
Interactive feel of the system	**33.33%** 3	**66.67%** 6	**0.00%** 0	**0.00%** 0	**0.00%** 0	9	4.33
Playability (Easy to Play)	**11.11%** 1	**77.78%** 7	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	4.00

Q6 Please list the most positive aspects of the COLORS application you observed

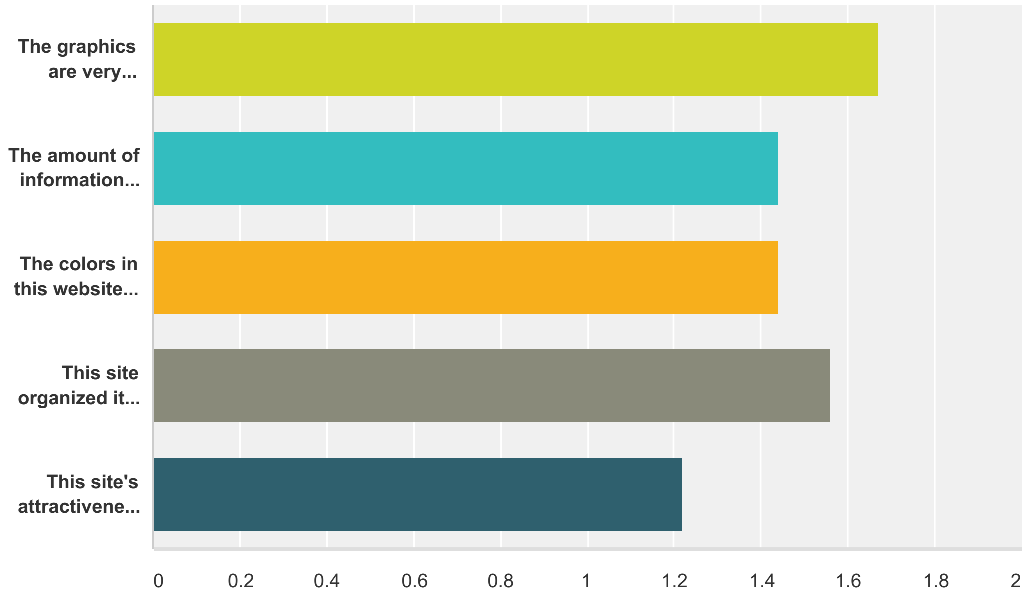
Answered: 9 Skipped: 8

Q7 Please list the most negative aspects of the COLORS application you observed

Answered: 8 Skipped: 9

Q8 Design (COLORS)

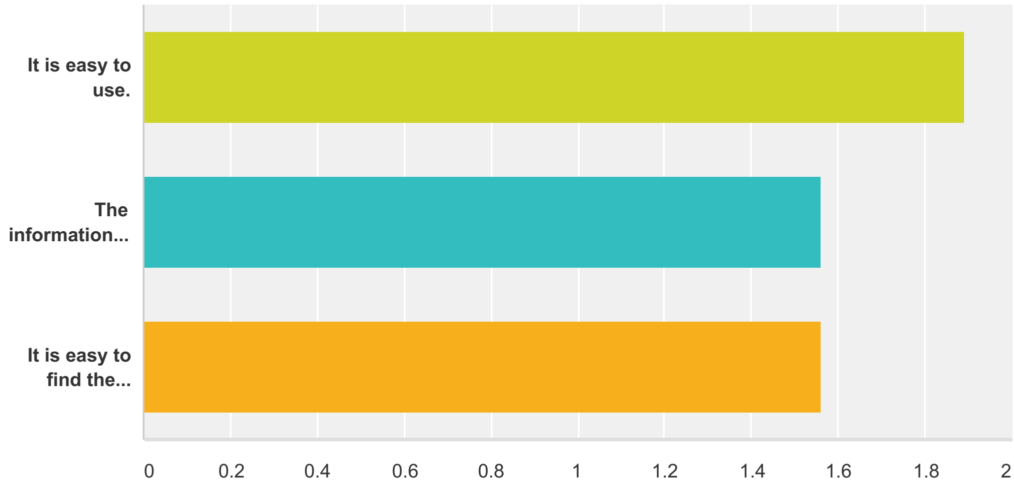
Answered: 9 Skipped: 8



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
The graphics are very appropriate for this site.	**44.44%** 4	**44.44%** 4	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.67
The amount of information displayed is just right.	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44
The colors in this website are pleasant.	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44
This site organized its information in a way that is easy for me to understand.	**44.44%** 4	**55.56%** 5	**0.00%** 0	**0.00%** 0	**0.00%** 0	9	1.56
This site's attractiveness invites me to go further into this site.	**77.78%** 7	**22.22%** 2	**0.00%** 0	**0.00%** 0	**0.00%** 0	9	1.22

Q9 EASE OF USE (COLORS)

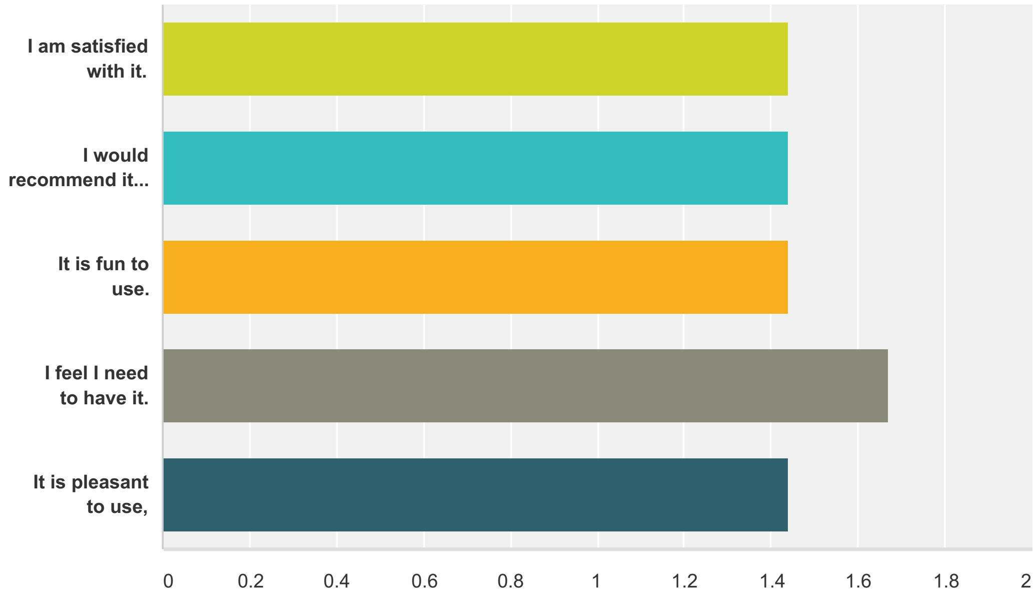
Answered: 9 Skipped: 8



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
It is easy to use.	**33.33%** 3	**44.44%** 4	**22.22%** 2	**0.00%** 0	**0.00%** 0	9	1.89
The information provided is easy to understand.	**44.44%** 4	**55.56%** 5	**0.00%** 0	**0.00%** 0	**0.00%** 0	9	1.56
It is easy to find the information I needed.	**55.56%** 5	**33.33%** 3	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.56

Q10 SATISFACTION (COLORS)

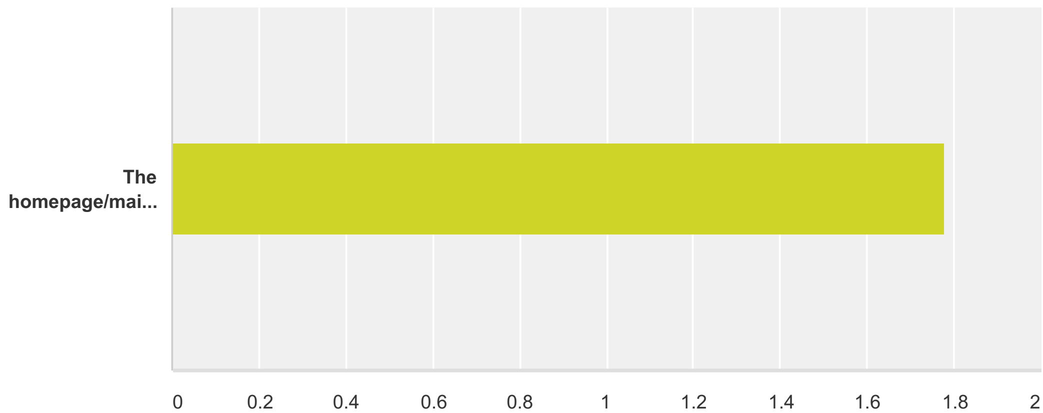
Answered: 9 Skipped: 8



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
I am satisfied with it.	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44
I would recommend it to a friend.	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44
It is fun to use.	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44
I feel I need to have it.	**55.56%** 5	**22.22%** 2	**22.22%** 2	**0.00%** 0	**0.00%** 0	9	1.67
It is pleasant to use,	**66.67%** 6	**22.22%** 2	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.44

Q11 HOMEPAGE (COLORS)

Answered: 9 Skipped: 8



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
The homepage/main page of this website is eye-catching and visually interesting.	**33.33%** 3	**55.56%** 5	**11.11%** 1	**0.00%** 0	**0.00%** 0	9	1.78

Q12 Do you have any suggestions for improving COLORS application?

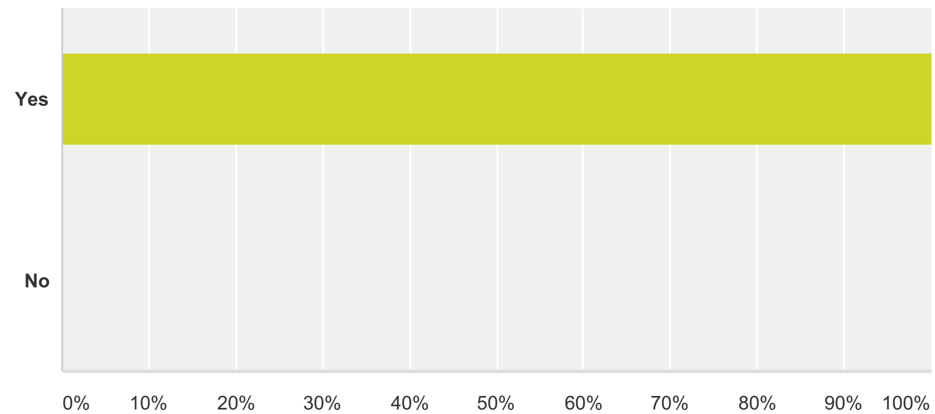
Answered: 9 Skipped: 8

Q13 What do you dislike about COLORS?

Answered: 8 Skipped: 9

Q14 Overall, I would recommend the COLORS application to others.

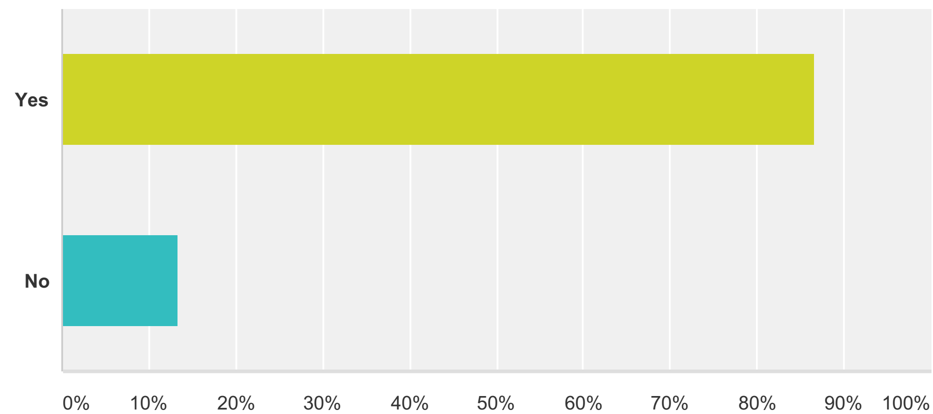
Answered: 9 Skipped: 8



Answer Choices	Responses	
Yes	100.00%	9
No	0.00%	0
Total		9

Q15 Did you review the ChemiNet(http://cheminet.azurewebsites.net/) application?

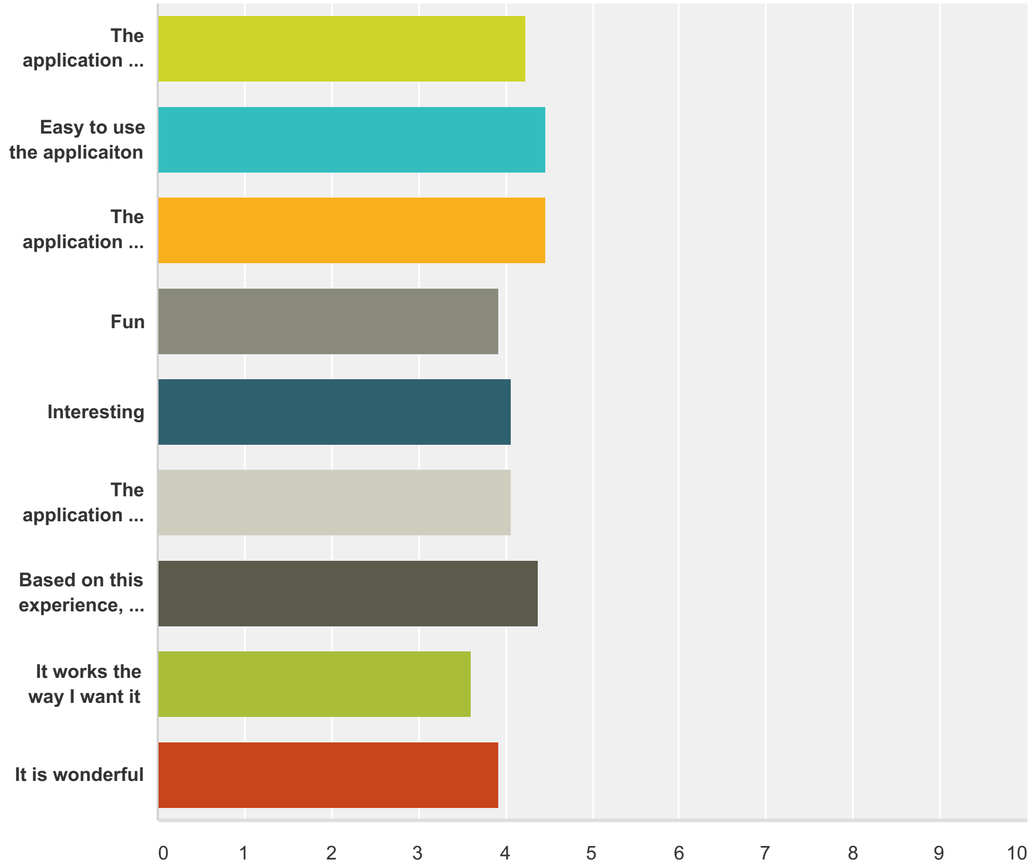
Answered: 15 Skipped: 2



Answer Choices	Responses	
Yes	**86.67%**	13
No	**13.33%**	2
Total		**15**

Q16 What is the overall reaction to the ChemiNet Application?

Answered: 13 Skipped: 4

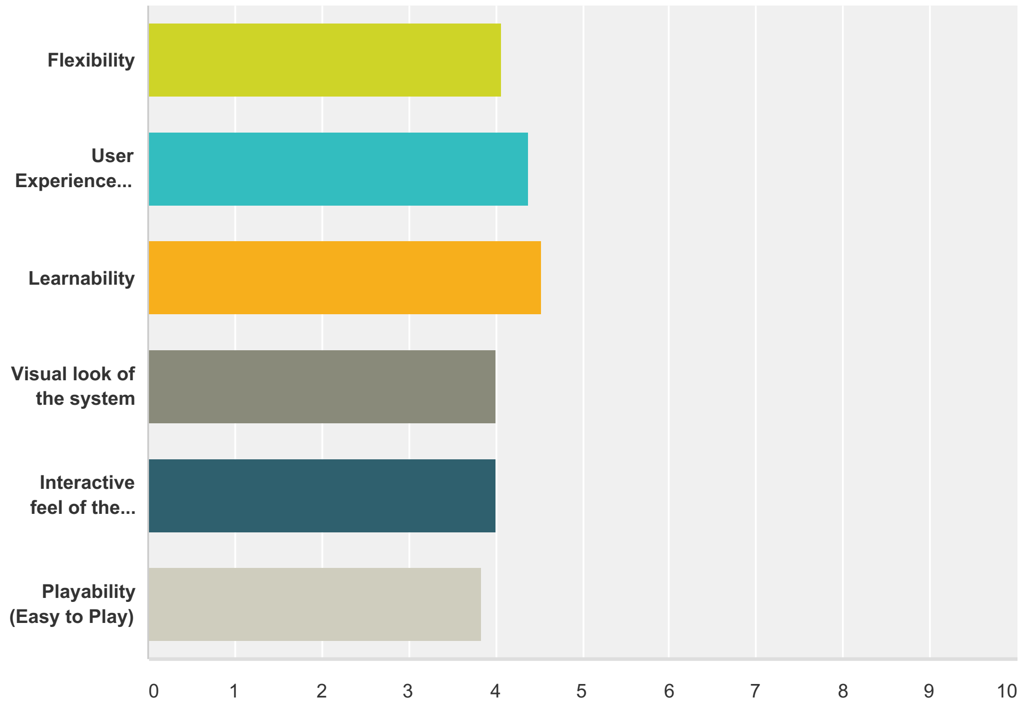


	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Total	Weighted Average
The application is attractive	**46.15%** 6	**38.46%** 5	**7.69%** 1	**7.69%** 1	**0.00%** 0	13	4.23
Easy to use the applicaiton	**61.54%** 8	**23.08%** 3	**15.38%** 2	**0.00%** 0	**0.00%** 0	13	4.46
The application is easy to learn to use	**61.54%** 8	**23.08%** 3	**15.38%** 2	**0.00%** 0	**0.00%** 0	13	4.46
Fun	**38.46%** 5	**30.77%** 4	**23.08%** 3	**0.00%** 0	**7.69%** 1	13	3.92
Interesting	**61.54%** 8	**7.69%** 1	**15.38%** 2	**7.69%** 1	**7.69%** 1	13	4.08
The application is flexible to play	**46.15%** 6	**30.77%** 4	**15.38%** 2	**0.00%** 0	**7.69%** 1	13	4.08
Based on this experience, I will use this site if available	**61.54%** 8	**15.38%** 2	**23.08%** 3	**0.00%** 0	**0.00%** 0	13	4.38
It works the way I want it	**38.46%** 5	**15.38%** 2	**30.77%** 4	**0.00%** 0	**15.38%** 2	13	3.62

It is wonderful	**46.15%** 6	**23.08%** 3	**15.38%** 2	**7.69%** 1	**7.69%** 1	13	3.92

Q17 Please rate ChemiNet with respect to following aspects:

Answered: 13 Skipped: 4



	Very High	High	Moderate	Low	Very Low	Total	Weighted Average
Flexibility	**30.77%** 4	**46.15%** 6	**23.08%** 3	**0.00%** 0	**0.00%** 0	13	4.08
User Experience (Good feeling about the system)	**53.85%** 7	**30.77%** 4	**15.38%** 2	**0.00%** 0	**0.00%** 0	13	4.38
Learnability	**61.54%** 8	**30.77%** 4	**7.69%** 1	**0.00%** 0	**0.00%** 0	13	4.54
Visual look of the system	**25.00%** 3	**50.00%** 6	**25.00%** 3	**0.00%** 0	**0.00%** 0	12	4.00
Interactive feel of the system	**30.77%** 4	**46.15%** 6	**15.38%** 2	**7.69%** 1	**0.00%** 0	13	4.00
Playability (Easy to Play)	**30.77%** 4	**30.77%** 4	**30.77%** 4	**7.69%** 1	**0.00%** 0	13	3.85

Q18 Please list the most positive aspects of the ChemiNet application you observed

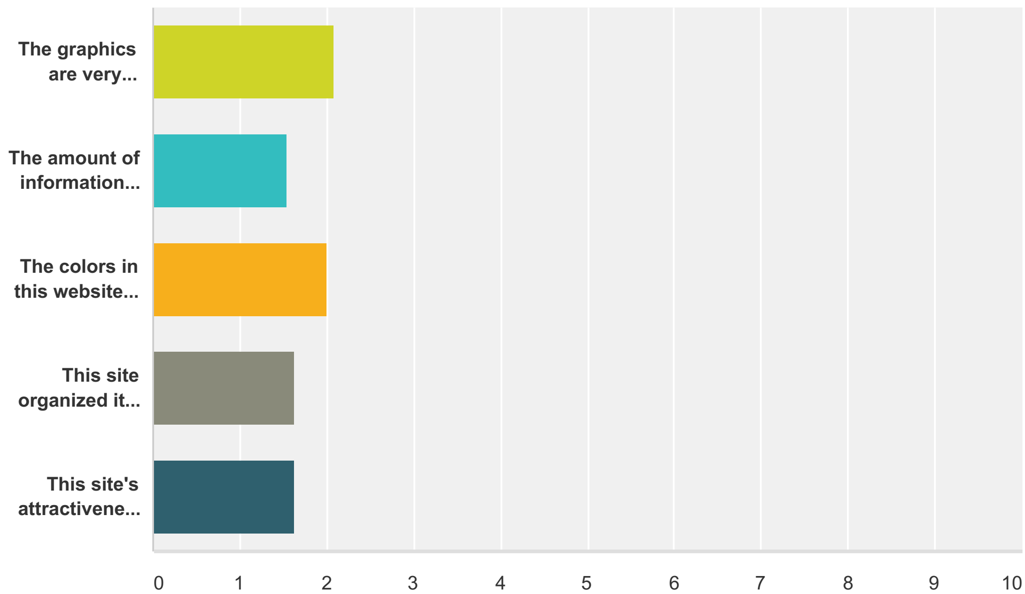
Answered: 10 Skipped: 7

Q19 Please list the most negative aspects of the ChemiNet application you observed

Answered: 11 Skipped: 6

Q20 Design (ChemiNet)

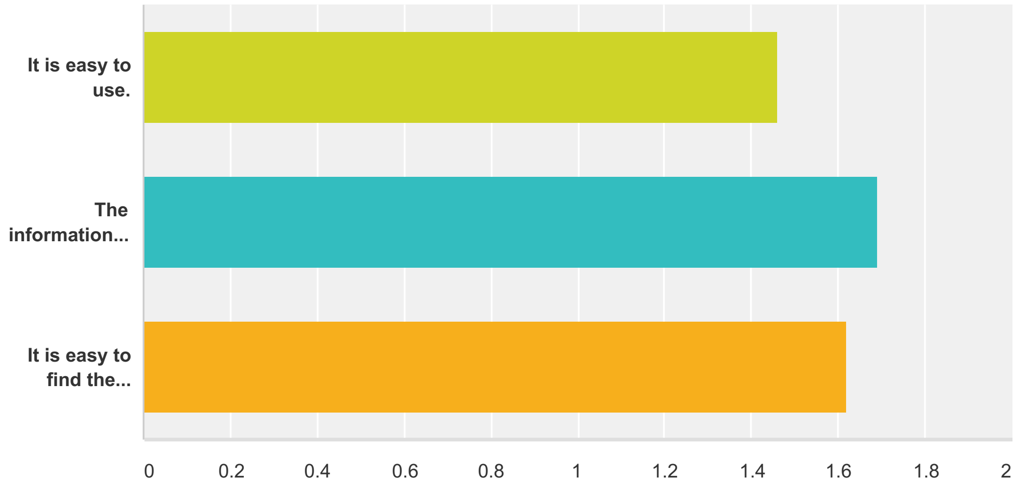
Answered: 13 Skipped: 4



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
The graphics are very appropriate for this site.	**38.46%** 5	**38.46%** 5	**7.69%** 1	**7.69%** 1	**7.69%** 1	13	2.08
The amount of information displayed is just right.	**53.85%** 7	**38.46%** 5	**7.69%** 1	**0.00%** 0	**0.00%** 0	13	1.54
The colors in this website are pleasant.	**38.46%** 5	**38.46%** 5	**15.38%** 2	**0.00%** 0	**7.69%** 1	13	2.00
This site organized its information in a way that is easy for me to understand.	**46.15%** 6	**46.15%** 6	**7.69%** 1	**0.00%** 0	**0.00%** 0	13	1.62
This site's attractiveness invites me to go further into this site.	**53.85%** 7	**38.46%** 5	**0.00%** 0	**7.69%** 1	**0.00%** 0	13	1.62

Q21 EASE OF USE (ChemiNet)

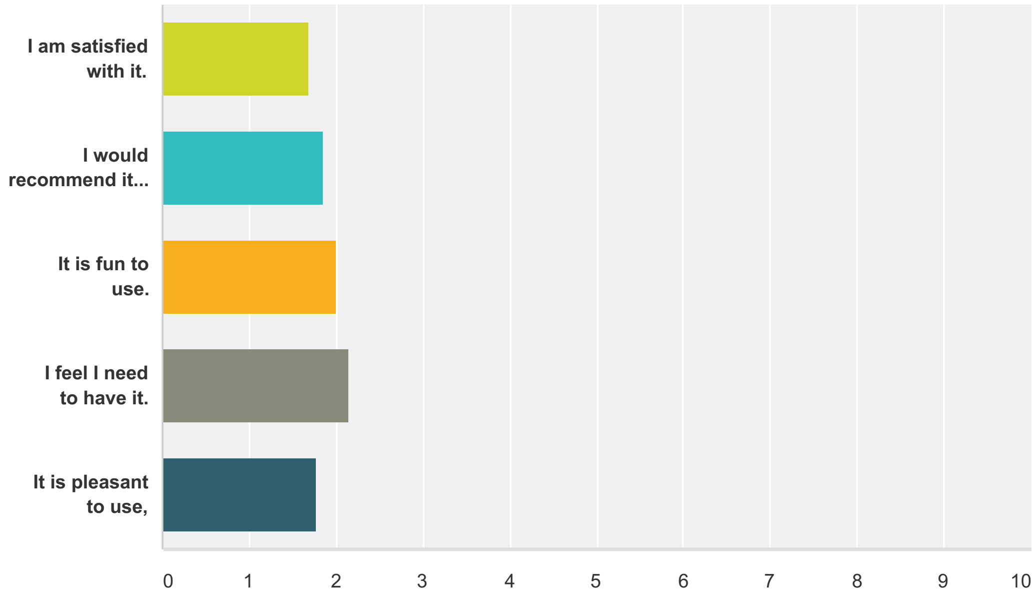
Answered: 13 Skipped: 4



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
It is easy to use.	**53.85%** 7	**46.15%** 6	**0.00%** 0	**0.00%** 0	**0.00%** 0	13	1.46
The information provided is easy to understand.	**46.15%** 6	**38.46%** 5	**15.38%** 2	**0.00%** 0	**0.00%** 0	13	1.69
It is easy to find the information I needed.	**46.15%** 6	**46.15%** 6	**7.69%** 1	**0.00%** 0	**0.00%** 0	13	1.62

Q22 SATISFACTION (ChemiNet)

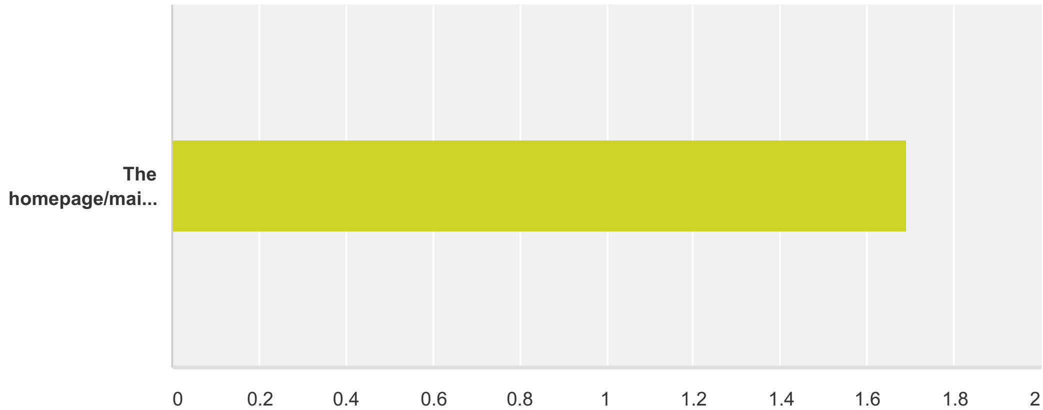
Answered: 13 Skipped: 4



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
I am satisfied with it.	**38.46%** 5	**53.85%** 7	**7.69%** 1	**0.00%** 0	**0.00%** 0	13	1.69
I would recommend it to a friend.	**46.15%** 6	**38.46%** 5	**7.69%** 1	**0.00%** 0	**7.69%** 1	13	1.85
It is fun to use.	**38.46%** 5	**38.46%** 5	**15.38%** 2	**0.00%** 0	**7.69%** 1	13	2.00
I feel I need to have it.	**46.15%** 6	**30.77%** 4	**0.00%** 0	**7.69%** 1	**15.38%** 2	13	2.15
It is pleasant to use,	**46.15%** 6	**38.46%** 5	**7.69%** 1	**7.69%** 1	**0.00%** 0	13	1.77

Q23 HOMEPAGE (ChemiNet)

Answered: 13 Skipped: 4



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Weighted Average
The homepage/main page of this website is eye-catching and visually interesting.	**61.54%** 8	**23.08%** 3	**7.69%** 1	**0.00%** 0	**7.69%** 1	13	1.69

Q24 Do you have any suggestions for improving ChemiNet application?

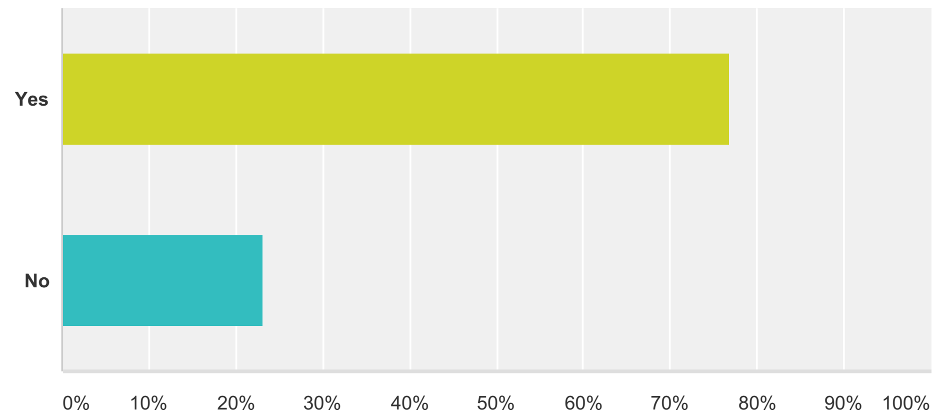
Answered: 12 Skipped: 5

Q25 What do you dislike about ChemiNet?

Answered: 12 Skipped: 5

Q26 Overall, I would recommend the ChemiNet application to others.

Answered: 13 Skipped: 4

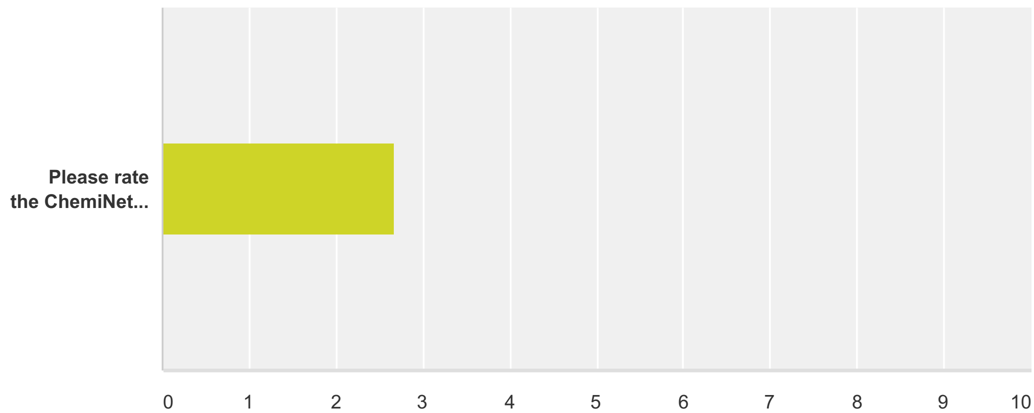


Answer Choices	Responses	
Yes	**76.92%**	10
No	**23.08%**	3
Total		**13**

APPENDIX J (14 pages)

Q1 Please rate the ChemiNet application

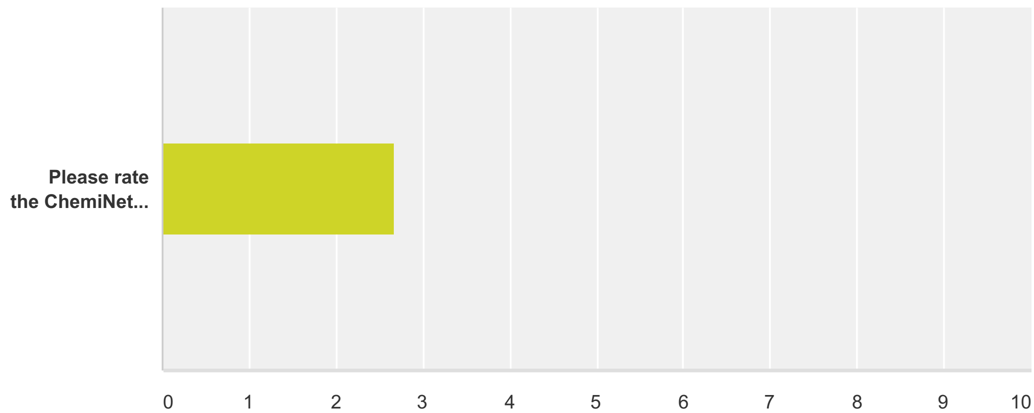
Answered: 12 Skipped: 0



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the ChemiNet application	**8.33%** 1	**25.00%** 3	**58.33%** 7	**8.33%** 1	**0.00%** 0	12	2.67

Q2 Please rate the ChemiNet application

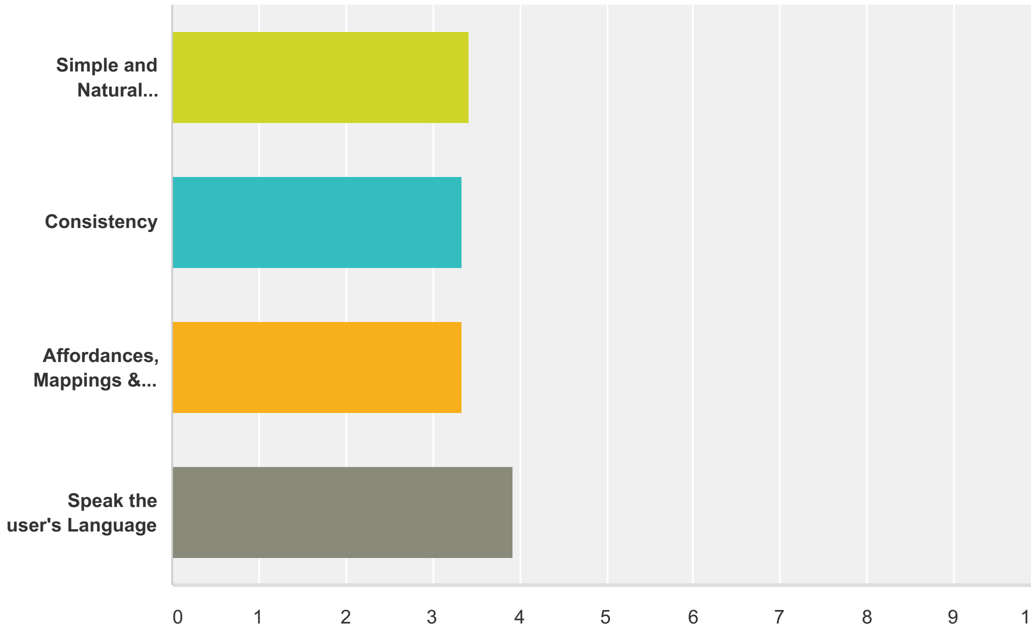
Answered: 12 Skipped: 0



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the ChemiNet application	**8.33%** 1	**25.00%** 3	**58.33%** 7	**8.33%** 1	**0.00%** 0	12	2.67

Q3 Please rate the ChemiNet application

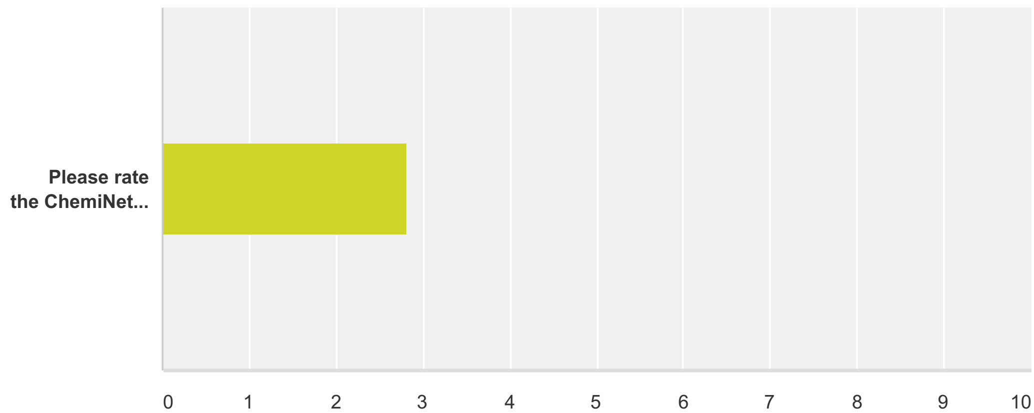
Answered: 12 Skipped: 0



	Strongly Disagree (1)	(2)	(3)	(4)	Strongly Agree (5)	Total	Weighted Average
Simple and Natural Dialogue	**0.00%** 0	**25.00%** 3	**25.00%** 3	**33.33%** 4	**16.67%** 2	12	3.42
Consistency	**0.00%** 0	**25.00%** 3	**33.33%** 4	**25.00%** 3	**16.67%** 2	12	3.33
Affordances, Mappings & Constraints	**8.33%** 1	**16.67%** 2	**25.00%** 3	**33.33%** 4	**16.67%** 2	12	3.33
Speak the user's Language	**0.00%** 0	**0.00%** 0	**25.00%** 3	**58.33%** 7	**16.67%** 2	12	3.92

Q4 Please rate the ChemiNet application

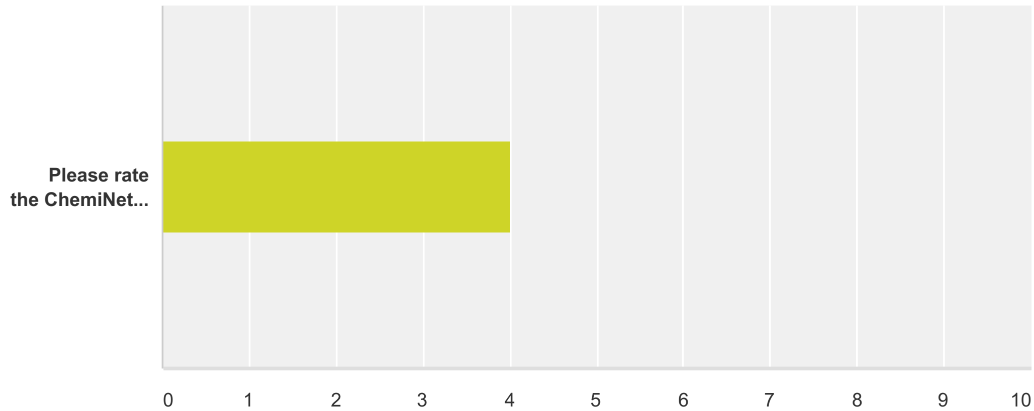
Answered: 11 Skipped: 1



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the ChemiNet application	**0.00%** 0	**27.27%** 3	**63.64%** 7	**9.09%** 1	**0.00%** 0	11	2.82

Q5 Please rate the ChemiNet application

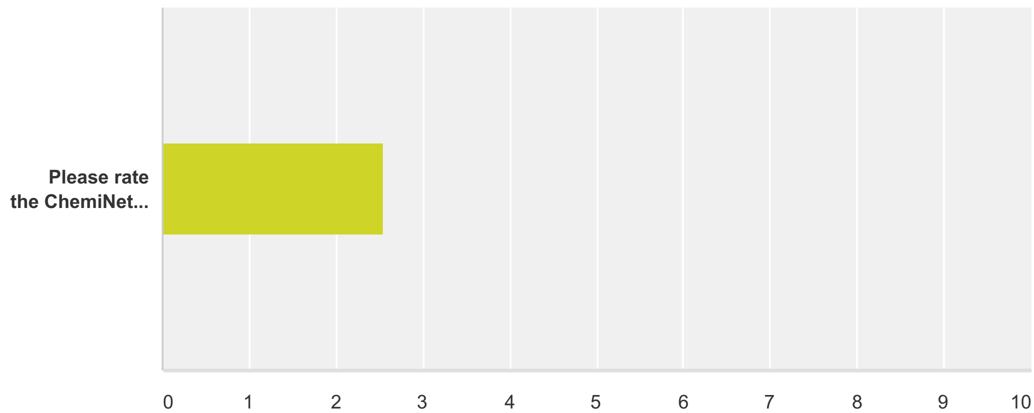
Answered: 12 Skipped: 0



	Difficult (1)	(2)	(3)	(4)	Easy (5)	Total	Weighted Average
Please rate the ChemiNet application	**0.00%** 0	**8.33%** 1	**25.00%** 3	**25.00%** 3	**41.67%** 5	12	4.00

Q6 Please rate the ChemiNet application

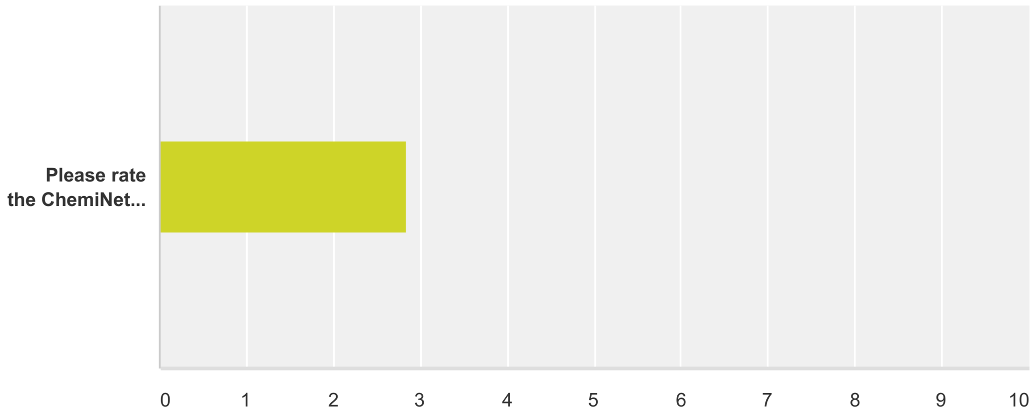
Answered: 11 Skipped: 1



	Dull (1)	(2)	(3)	(4)	Stimulating (5)	Total	Weighted Average
Please rate the ChemiNet application	**18.18%** 2	**27.27%** 3	**36.36%** 4	**18.18%** 2	**0.00%** 0	11	2.55

Q7 Please rate the ChemiNet application

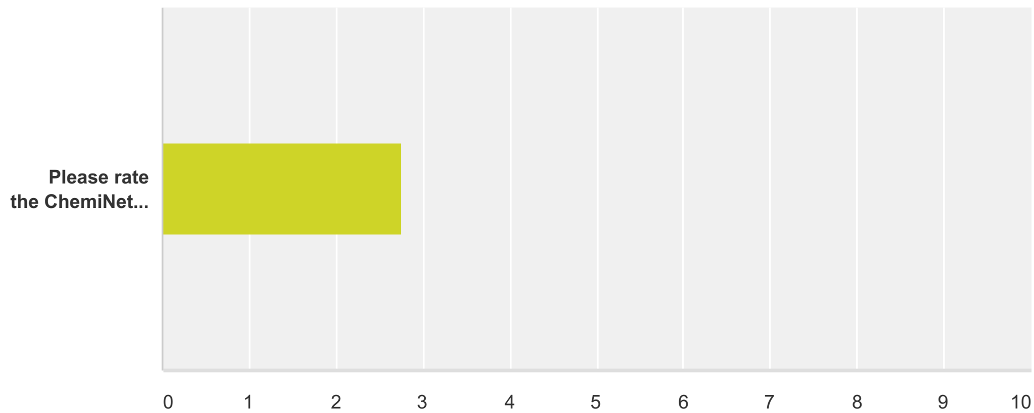
Answered: 12 Skipped: 0



	Frustrating (1)	(2)	(3)	(4)	Satisfying (5)	Total	Weighted Average
Please rate the ChemiNet application	**8.33%** 1	**16.67%** 2	**58.33%** 7	**16.67%** 2	**0.00%** 0	12	2.83

Q8 Please rate the ChemiNet application

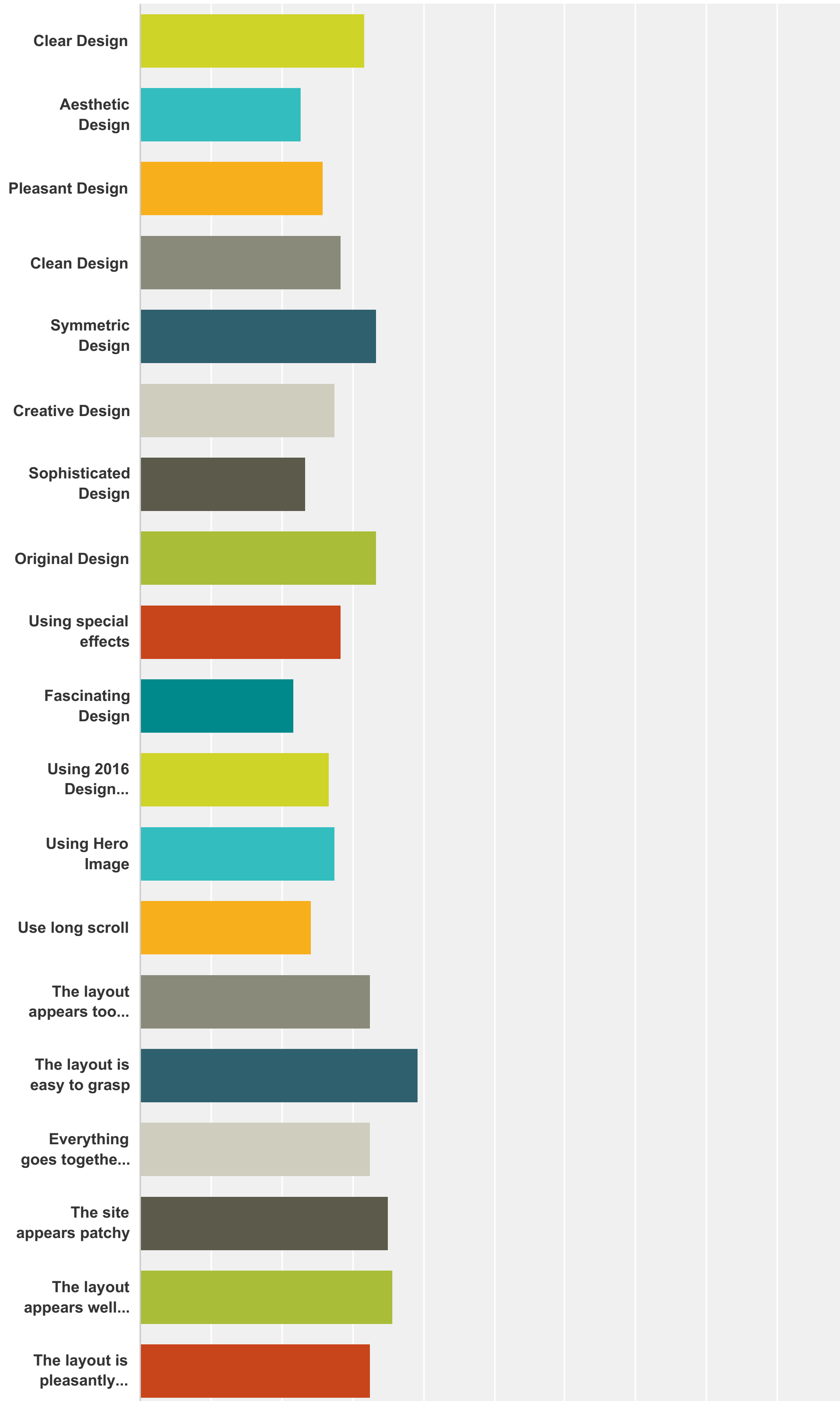
Answered: 12 Skipped: 0

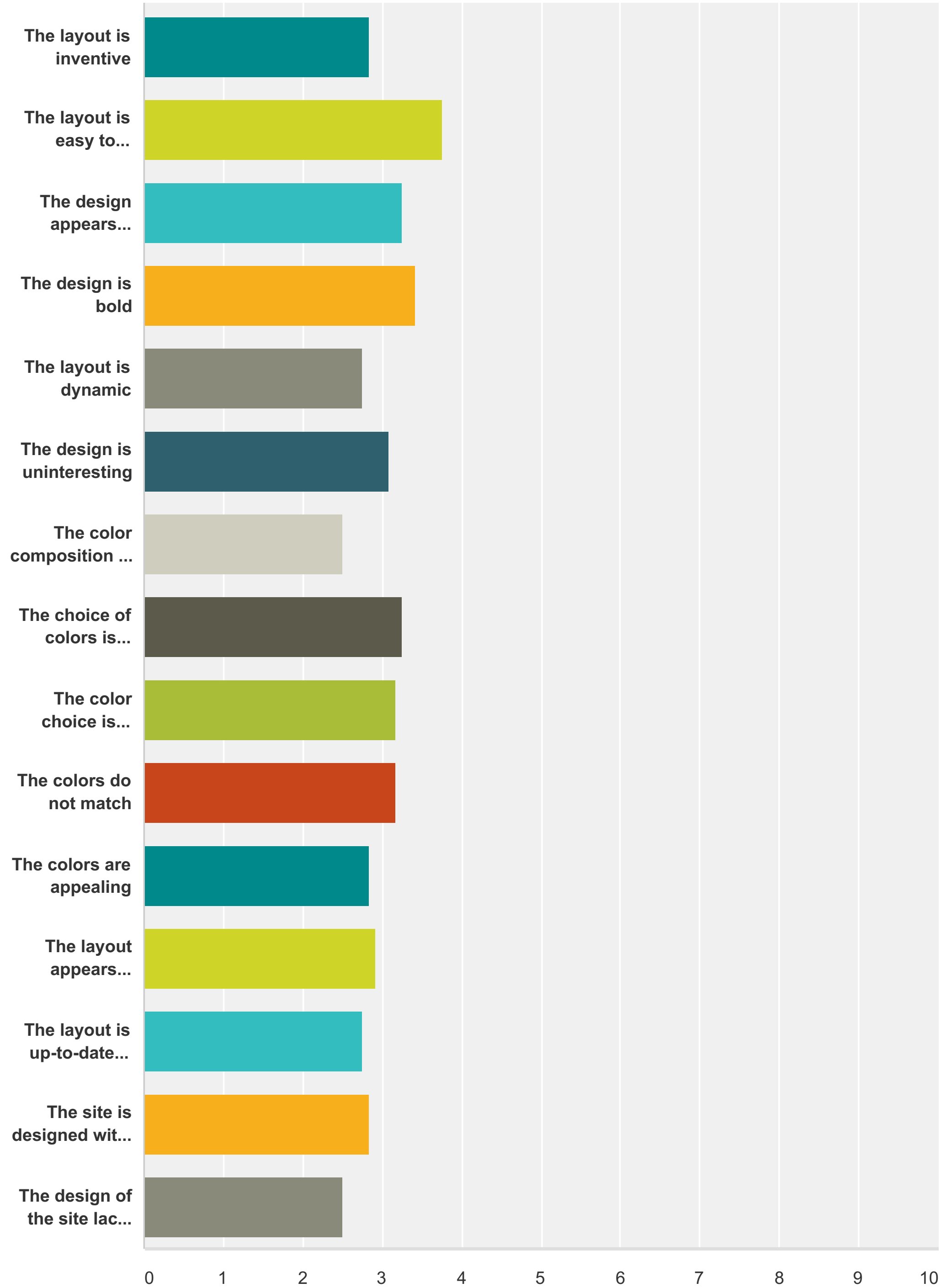


	Rigid (1)	(2)	(3)	(4)	Flexible (5)	Total	Weighted Average
Please rate the ChemiNet application	**8.33%** 1	**16.67%** 2	**66.67%** 8	**8.33%** 1	**0.00%** 0	12	2.75

Q9 Please rate the ChemiNet application

Answered: 12 Skipped: 0





	Strongly Disagree (1)	(2)	(3)	(4)	Strongly Agree (5)	Total	Weighted Average
Clear Design	**16.67%** 2	**0.00%** 0	**33.33%** 4	**50.00%** 6	**0.00%** 0	12	3.17
Aesthetic Design	**18.18%** 2	**45.45%** 5	**27.27%** 3	**9.09%** 1	**0.00%** 0	11	2.27
Pleasant Design	**16.67%** 2	**25.00%** 3	**41.67%** 5	**16.67%** 2	**0.00%** 0	12	2.58
Clean Design	**8.33%** 1	**33.33%** 4	**33.33%** 4	**16.67%** 2	**8.33%** 1	12	2.83

Symmetric Design	**8.33%** 1	**0.00%** 0	**50.00%** 6	**33.33%** 4	**8.33%** 1	12	3.33
Creative Design	**8.33%** 1	**25.00%** 3	**50.00%** 6	**16.67%** 2	**0.00%** 0	12	2.75
Sophisticated Design	**16.67%** 2	**41.67%** 5	**33.33%** 4	**8.33%** 1	**0.00%** 0	12	2.33
Original Design	**8.33%** 1	**0.00%** 0	**50.00%** 6	**33.33%** 4	**8.33%** 1	12	3.33
Using special effects	**8.33%** 1	**33.33%** 4	**33.33%** 4	**16.67%** 2	**8.33%** 1	12	2.83
Fascinating Design	**16.67%** 2	**50.00%** 6	**33.33%** 4	**0.00%** 0	**0.00%** 0	12	2.17
Using 2016 Design principles	**16.67%** 2	**16.67%** 2	**50.00%** 6	**16.67%** 2	**0.00%** 0	12	2.67
Using Hero Image	**25.00%** 3	**8.33%** 1	**41.67%** 5	**16.67%** 2	**8.33%** 1	12	2.75
Use long scroll	**25.00%** 3	**16.67%** 2	**50.00%** 6	**8.33%** 1	**0.00%** 0	12	2.42
The layout appears too dense	**0.00%** 0	**33.33%** 4	**16.67%** 2	**41.67%** 5	**8.33%** 1	12	3.25
The layout is easy to grasp	**8.33%** 1	**0.00%** 0	**16.67%** 2	**41.67%** 5	**33.33%** 4	12	3.92
Everything goes together on the site	**0.00%** 0	**16.67%** 2	**50.00%** 6	**25.00%** 3	**8.33%** 1	12	3.25
The site appears patchy	**0.00%** 0	**8.33%** 1	**50.00%** 6	**25.00%** 3	**16.67%** 2	12	3.50
The layout appears well structured	**8.33%** 1	**0.00%** 0	**25.00%** 3	**58.33%** 7	**8.33%** 1	12	3.58
The layout is pleasantly varied	**8.33%** 1	**8.33%** 1	**33.33%** 4	**50.00%** 6	**0.00%** 0	12	3.25
The layout is inventive	**8.33%** 1	**33.33%** 4	**25.00%** 3	**33.33%** 4	**0.00%** 0	12	2.83
The layout is easy to navigate	**8.33%** 1	**0.00%** 0	**25.00%** 3	**41.67%** 5	**25.00%** 3	12	3.75
The design appears uninspired	**0.00%** 0	**25.00%** 3	**41.67%** 5	**16.67%** 2	**16.67%** 2	12	3.25
The design is bold	**0.00%** 0	**16.67%** 2	**50.00%** 6	**8.33%** 1	**25.00%** 3	12	3.42
The layout is dynamic	**8.33%** 1	**25.00%** 3	**58.33%** 7	**0.00%** 0	**8.33%** 1	12	2.75
The design is uninteresting	**0.00%** 0	**33.33%** 4	**41.67%** 5	**8.33%** 1	**16.67%** 2	12	3.08
The color composition is attractive	**25.00%** 3	**16.67%** 2	**41.67%** 5	**16.67%** 2	**0.00%** 0	12	2.50
The choice of colors is botched	**0.00%** 0	**25.00%** 3	**50.00%** 6	**0.00%** 0	**25.00%** 3	12	3.25
The color choice is appropriate for target age group (13-17)	**16.67%** 2	**16.67%** 2	**16.67%** 2	**33.33%** 4	**16.67%** 2	12	3.17
The colors do not match	**8.33%** 1	**25.00%** 3	**33.33%** 4	**8.33%** 1	**25.00%** 3	12	3.17

The colors are appealing	**16.67%** 2	**16.67%** 2	**33.33%** 4	**33.33%** 4	**0.00%** 0	12	2.83
The layout appears professionally designed	**16.67%** 2	**16.67%** 2	**41.67%** 5	**8.33%** 1	**16.67%** 2	12	2.92
The layout is up-to-date (2015 - 2016 Web design techniques)	**16.67%** 2	**16.67%** 2	**50.00%** 6	**8.33%** 1	**8.33%** 1	12	2.75
The site is designed with care	**16.67%** 2	**16.67%** 2	**41.67%** 5	**16.67%** 2	**8.33%** 1	12	2.83
The design of the site lacks a concept	**25.00%** 3	**25.00%** 3	**25.00%** 3	**25.00%** 3	**0.00%** 0	12	2.50

Q10 What do you like least about the ChemiNet design?

Answered: 12 Skipped: 0

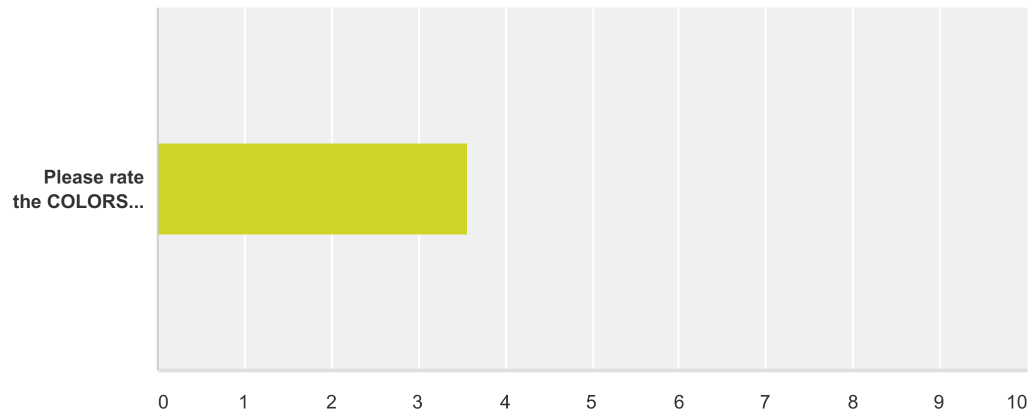
Q11 What do you like most about the ChemiNet design?

Answered: 10 Skipped: 2

APPENDIX K (14 pages)

Q1 Please rate the COLORS application

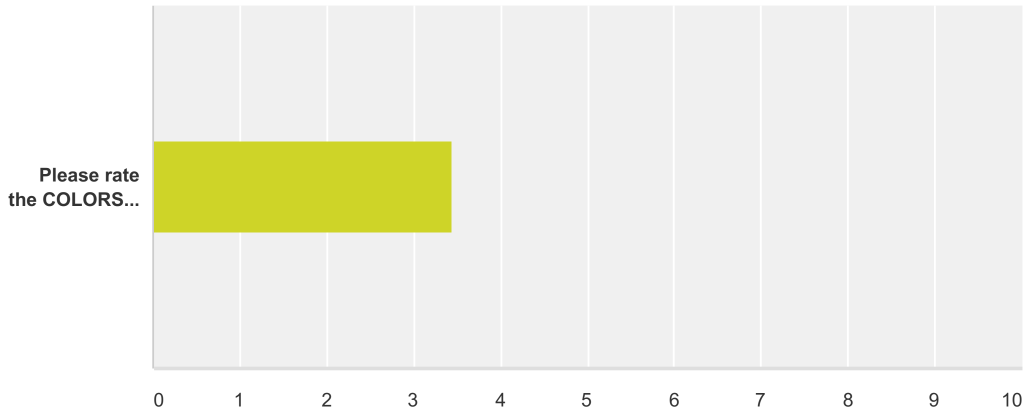
Answered: 9 Skipped: 0



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**11.11%** 1	**11.11%** 1	**44.44%** 4	**22.22%** 2	9	3.56

Q2 Please rate the COLORS application

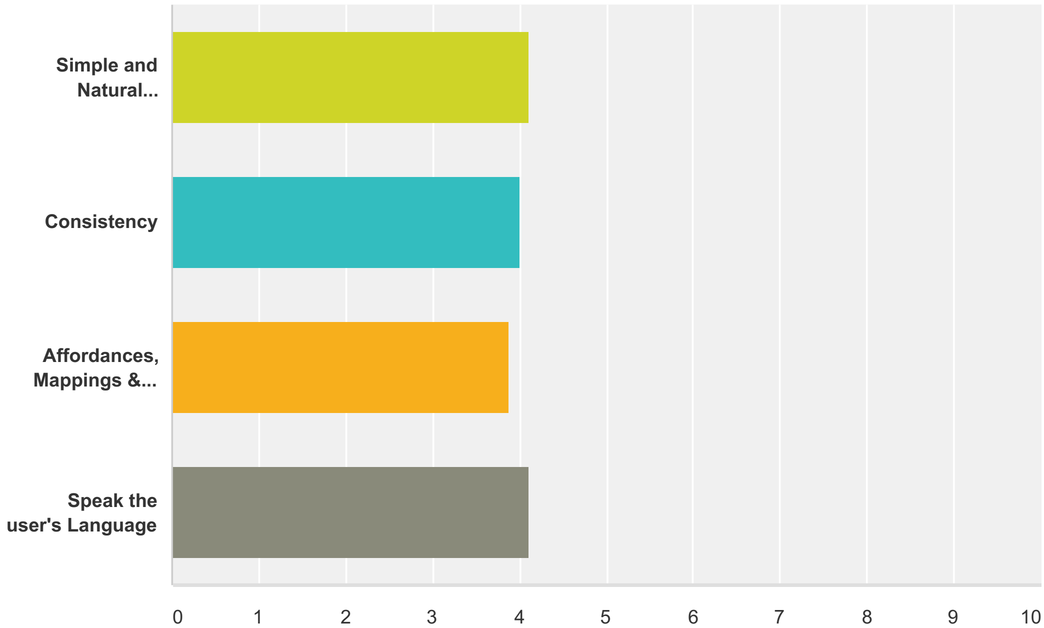
Answered: 9 Skipped: 0



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**11.11%** 1	**11.11%** 1	**55.56%** 5	**11.11%** 1	9	3.44

Q3 Please rate the COLORS application

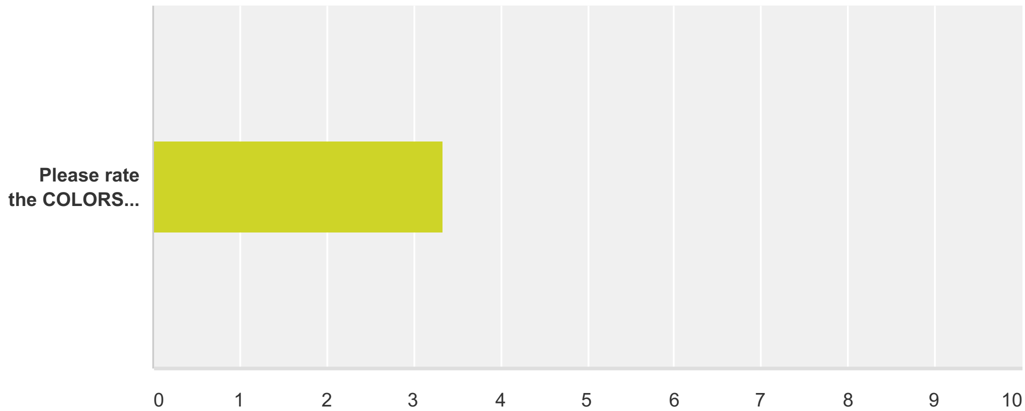
Answered: 9 Skipped: 0



	Strongly Disagree (1)	(2)	(3)	(4)	Strongly Agree (5)	Total	Weighted Average
Simple and Natural Dialogue	**0.00%** 0	**0.00%** 0	**22.22%** 2	**44.44%** 4	**33.33%** 3	9	4.11
Consistency	**11.11%** 1	**0.00%** 0	**11.11%** 1	**33.33%** 3	**44.44%** 4	9	4.00
Affordances, Mappings & Constraints	**0.00%** 0	**0.00%** 0	**22.22%** 2	**66.67%** 6	**11.11%** 1	9	3.89
Speak the user's Language	**0.00%** 0	**0.00%** 0	**22.22%** 2	**44.44%** 4	**33.33%** 3	9	4.11

Q4 Please rate the COLORS application

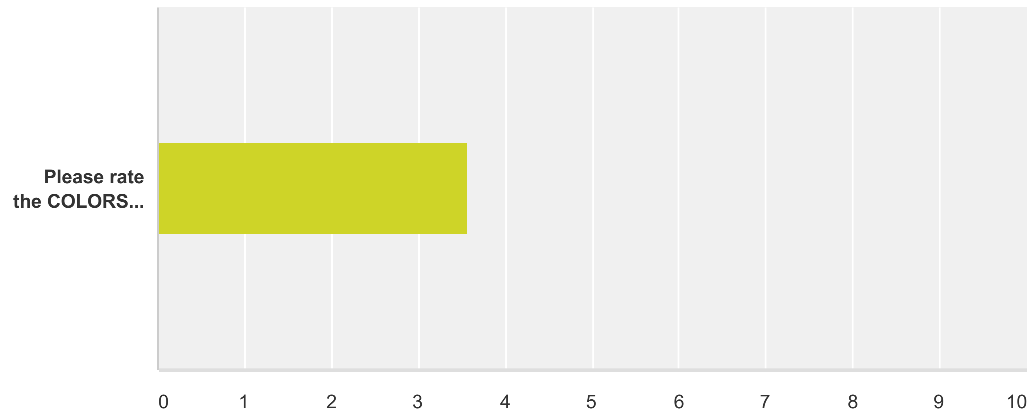
Answered: 9 Skipped: 0



	Terrible (1)	(2)	(3)	(4)	Wonderful (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**11.11%** 1	**22.22%** 2	**44.44%** 4	**11.11%** 1	9	3.33

Q5 Please rate the COLORS application

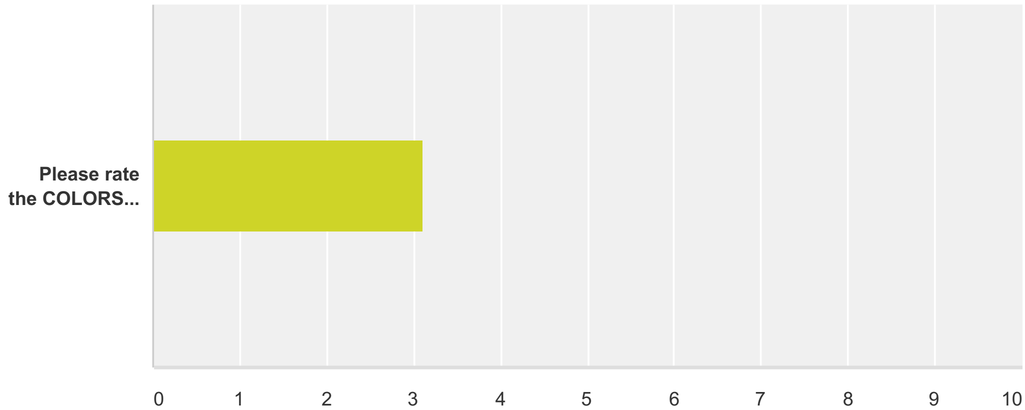
Answered: 9 Skipped: 0



	Difficult (1)	(2)	(3)	(4)	Easy (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**0.00%** 0	**44.44%** 4	**11.11%** 1	**33.33%** 3	9	3.56

Q6 Please rate the COLORS application

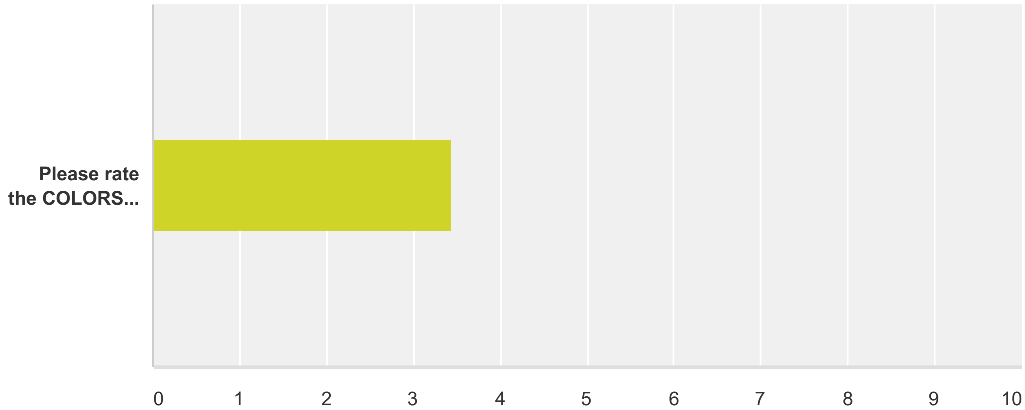
Answered: 9 Skipped: 0



	Dull (1)	(2)	(3)	(4)	Stimulating (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**33.33%** 3	**11.11%** 1	**22.22%** 2	**22.22%** 2	9	3.11

Q7 Please rate the COLORS application

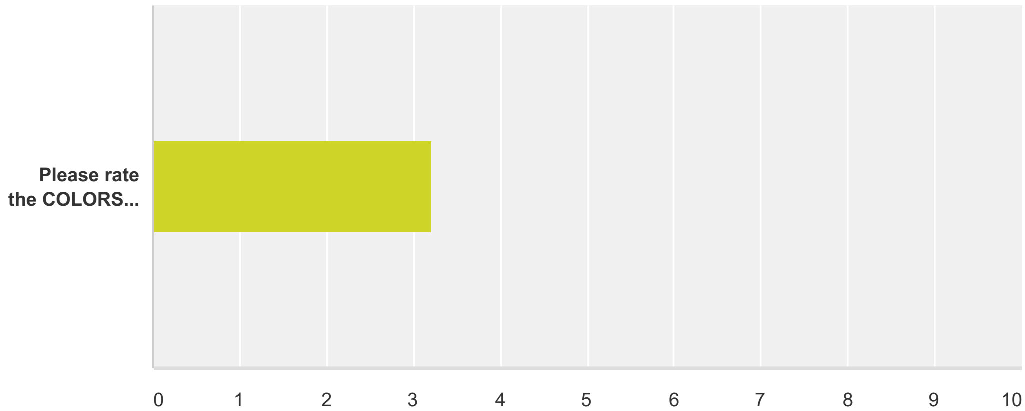
Answered: 9 Skipped: 0



	Frustrating (1)	(2)	(3)	(4)	Satisfying (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**11.11%** 1	**22.22%** 2	**33.33%** 3	**22.22%** 2	9	3.44

Q8 Please rate the COLORS application

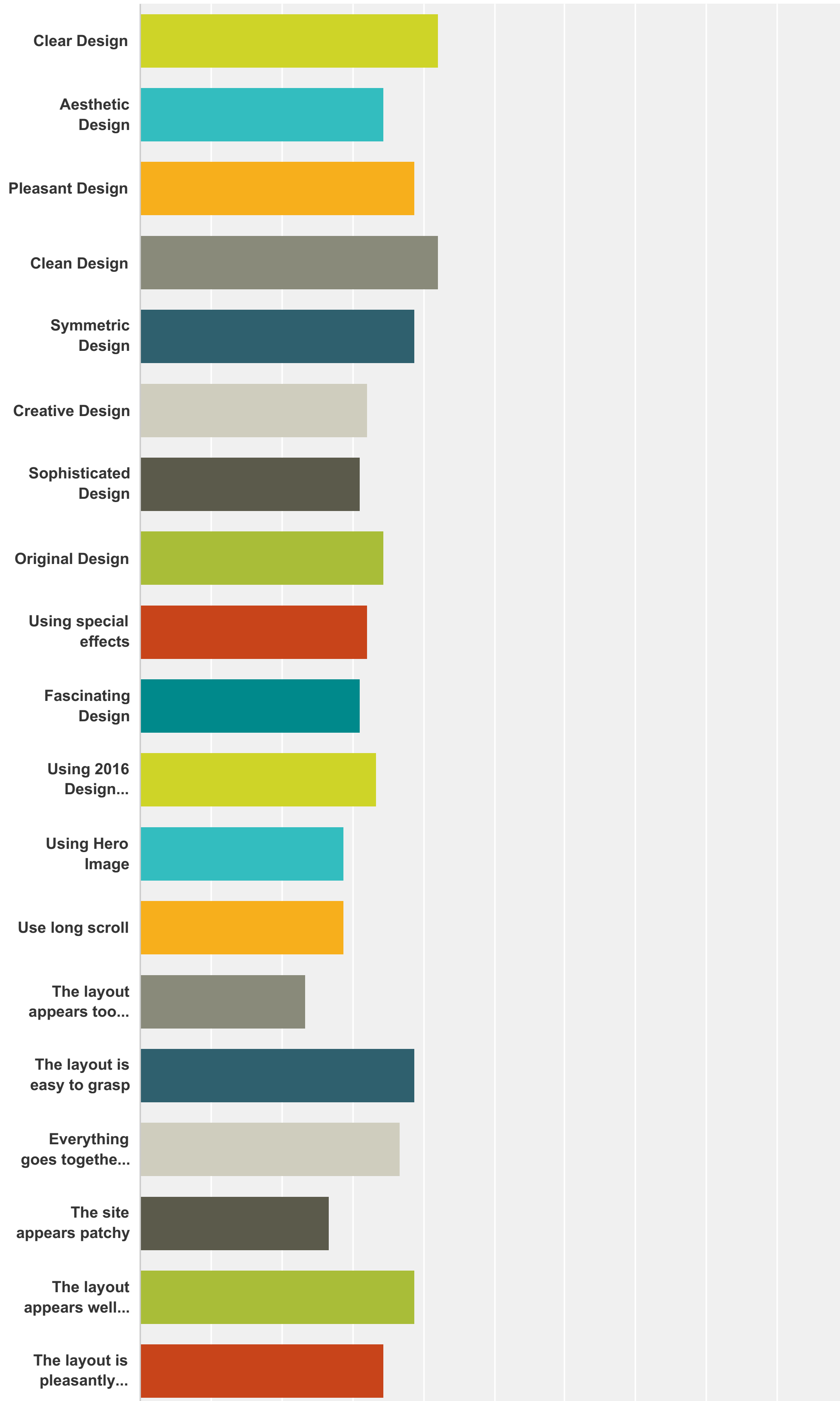
Answered: 9 Skipped: 0

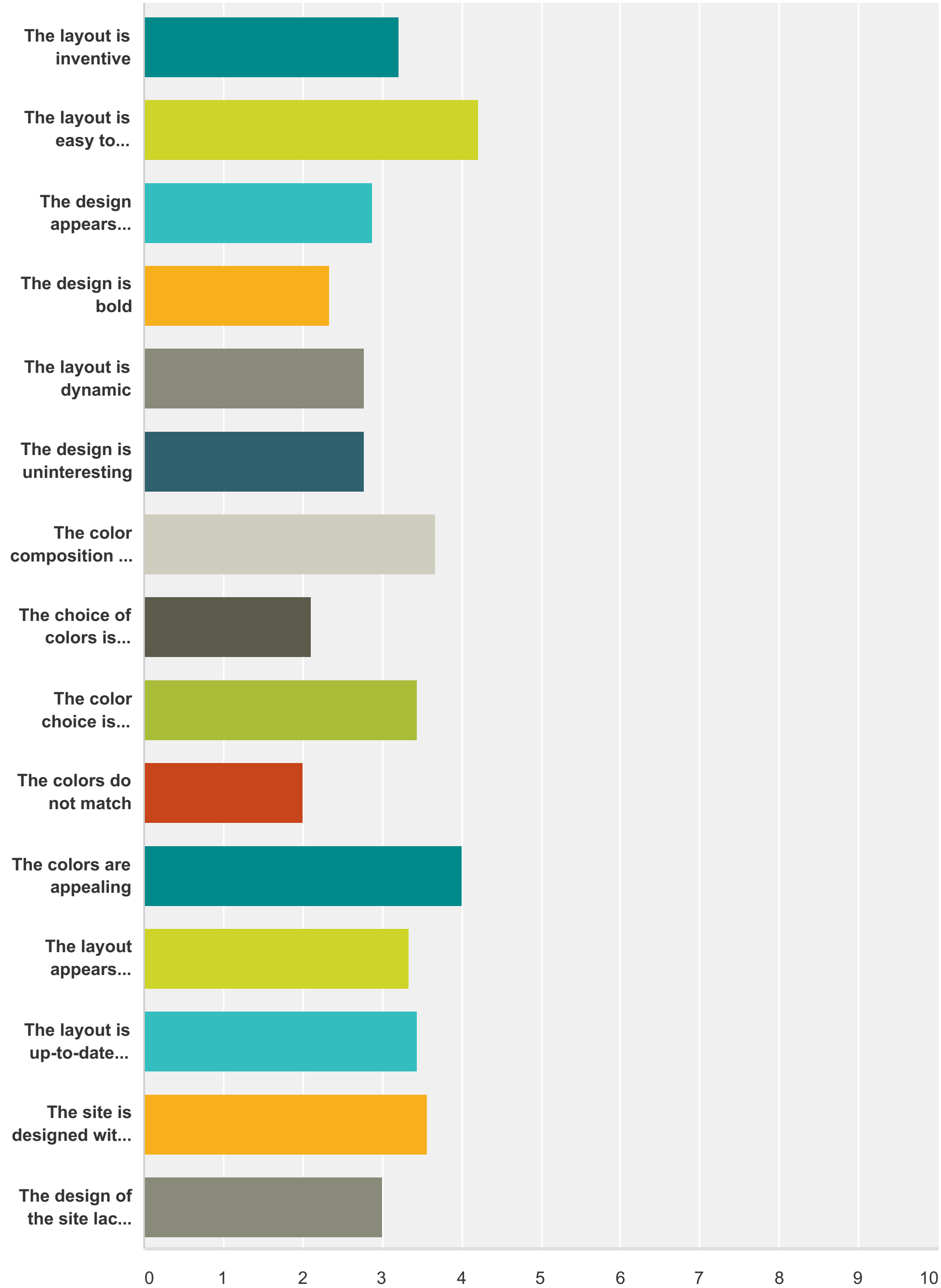


	Rigid (1)	(2)	(3)	(4)	Flexible (5)	Total	Weighted Average
Please rate the COLORS application	**11.11%** 1	**22.22%** 2	**22.22%** 2	**22.22%** 2	**22.22%** 2	9	3.22

Q9 Please rate the COLORS application

Answered: 9 Skipped: 0





	Strongly Disagree (1)	(2)	(3)	(4)	Strongly Agree (5)	Total	Weighted Average
Clear Design	**0.00%** 0	**0.00%** 0	**11.11%** 1	**55.56%** 5	**33.33%** 3	9	4.22
Aesthetic Design	**11.11%** 1	**11.11%** 1	**22.22%** 2	**33.33%** 3	**22.22%** 2	9	3.44
Pleasant Design	**0.00%** 0	**11.11%** 1	**11.11%** 1	**55.56%** 5	**22.22%** 2	9	3.89
Clean Design	**0.00%** 0	**0.00%** 0	**11.11%** 1	**55.56%** 5	**33.33%** 3	9	4.22

Symmetric Design	**0.00%** 0	**0.00%** 0	**22.22%** 2	**66.67%** 6	**11.11%** 1	9	3.89
Creative Design	**0.00%** 0	**22.22%** 2	**33.33%** 3	**44.44%** 4	**0.00%** 0	9	3.22
Sophisticated Design	**0.00%** 0	**44.44%** 4	**11.11%** 1	**33.33%** 3	**11.11%** 1	9	3.11
Original Design	**11.11%** 1	**11.11%** 1	**11.11%** 1	**55.56%** 5	**11.11%** 1	9	3.44
Using special effects	**22.22%** 2	**0.00%** 0	**33.33%** 3	**22.22%** 2	**22.22%** 2	9	3.22
Fascinating Design	**22.22%** 2	**0.00%** 0	**22.22%** 2	**55.56%** 5	**0.00%** 0	9	3.11
Using 2016 Design principles	**11.11%** 1	**0.00%** 0	**33.33%** 3	**55.56%** 5	**0.00%** 0	9	3.33
Using Hero Image	**22.22%** 2	**0.00%** 0	**55.56%** 5	**11.11%** 1	**11.11%** 1	9	2.89
Use long scroll	**11.11%** 1	**11.11%** 1	**55.56%** 5	**22.22%** 2	**0.00%** 0	9	2.89
The layout appears too dense	**11.11%** 1	**55.56%** 5	**22.22%** 2	**11.11%** 1	**0.00%** 0	9	2.33
The layout is easy to grasp	**0.00%** 0	**11.11%** 1	**11.11%** 1	**55.56%** 5	**22.22%** 2	9	3.89
Everything goes together on the site	**0.00%** 0	**11.11%** 1	**33.33%** 3	**33.33%** 3	**22.22%** 2	9	3.67
The site appears patchy	**11.11%** 1	**44.44%** 4	**22.22%** 2	**11.11%** 1	**11.11%** 1	9	2.67
The layout appears well structured	**0.00%** 0	**0.00%** 0	**22.22%** 2	**66.67%** 6	**11.11%** 1	9	3.89
The layout is pleasantly varied	**11.11%** 1	**0.00%** 0	**22.22%** 2	**66.67%** 6	**0.00%** 0	9	3.44
The layout is inventive	**11.11%** 1	**11.11%** 1	**22.22%** 2	**55.56%** 5	**0.00%** 0	9	3.22
The layout is easy to navigate	**0.00%** 0	**0.00%** 0	**11.11%** 1	**55.56%** 5	**33.33%** 3	9	4.22
The design appears uninspired	**11.11%** 1	**33.33%** 3	**22.22%** 2	**22.22%** 2	**11.11%** 1	9	2.89
The design is bold	**33.33%** 3	**22.22%** 2	**22.22%** 2	**22.22%** 2	**0.00%** 0	9	2.33
The layout is dynamic	**22.22%** 2	**22.22%** 2	**11.11%** 1	**44.44%** 4	**0.00%** 0	9	2.78
The design is uninteresting	**11.11%** 1	**44.44%** 4	**11.11%** 1	**22.22%** 2	**11.11%** 1	9	2.78
The color composition is attractive	**0.00%** 0	**0.00%** 0	**33.33%** 3	**66.67%** 6	**0.00%** 0	9	3.67
The choice of colors is botched	**44.44%** 4	**11.11%** 1	**33.33%** 3	**11.11%** 1	**0.00%** 0	9	2.11
The color choice is appropriate for target age group (13-17)	**11.11%** 1	**11.11%** 1	**22.22%** 2	**33.33%** 3	**22.22%** 2	9	3.44
The colors do not match	**33.33%** 3	**44.44%** 4	**11.11%** 1	**11.11%** 1	**0.00%** 0	9	2.00

The colors are appealing	**0.00%** 0	**0.00%** 0	**22.22%** 2	**55.56%** 5	**22.22%** 2	9	4.00
The layout appears professionally designed	**0.00%** 0	**22.22%** 2	**22.22%** 2	**55.56%** 5	**0.00%** 0	9	3.33
The layout is up-to-date (2015 - 2016 Web design techniques)	**0.00%** 0	**22.22%** 2	**22.22%** 2	**44.44%** 4	**11.11%** 1	9	3.44
The site is designed with care	**11.11%** 1	**0.00%** 0	**33.33%** 3	**33.33%** 3	**22.22%** 2	9	3.56
The design of the site lacks a concept	**0.00%** 0	**37.50%** 3	**37.50%** 3	**12.50%** 1	**12.50%** 1	8	3.00

Q10 What do you like least about the COLORS design?

Answered: 8 Skipped: 1

Q11 What do you like most about the COLORS design?

Answered: 9 Skipped: 0

APPENDIX L (80 pages)

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

Simple_NaturalDialogue	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	3	25.00	3	25.00
3	3	25.00	6	50.00
4	4	33.33	10	83.33
5	2	16.67	12	100.00

Consistency	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	3	25.00	3	25.00
3	4	33.33	7	58.33
4	3	25.00	10	83.33
5	2	16.67	12	100.00

AffordancesMappings_Constraints	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	2	16.67	3	25.00
3	3	25.00	6	50.00
4	4	33.33	10	83.33
5	2	16.67	12	100.00

SpeakUsersLanguage	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	3	25.00	3	25.00
4	7	58.33	10	83.33
5	2	16.67	12	100.00

Wonderful	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	4	33.33	4	33.33
3	7	58.33	11	91.67
4	1	8.33	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

Easy	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	8.33	1	8.33
3	3	25.00	4	33.33
4	3	25.00	7	58.33
5	5	41.67	12	100.00

Stimulating	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	4	33.33	6	50.00
3	4	33.33	10	83.33
4	2	16.67	12	100.00

Satisfying	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	2	16.67	3	25.00
3	7	58.33	10	83.33
4	2	16.67	12	100.00

Flexible	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	2	16.67	3	25.00
3	8	66.67	11	91.67
4	1	8.33	12	100.00

ClearDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
3	4	33.33	6	50.00
4	6	50.00	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

AestheticDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	6	50.00	8	66.67
3	3	25.00	11	91.67
4	1	8.33	12	100.00

PleasantDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	3	25.00	5	41.67
3	5	41.67	10	83.33
4	2	16.67	12	100.00

CleanDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	4	33.33	5	41.67
3	4	33.33	9	75.00
4	2	16.67	11	91.67
5	1	8.33	12	100.00

SymmetricDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
3	6	50.00	7	58.33
4	4	33.33	11	91.67
5	1	8.33	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

CreativeDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	3	25.00	4	33.33
3	6	50.00	10	83.33
4	2	16.67	12	100.00

SophisticatedDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	5	41.67	7	58.33
3	4	33.33	11	91.67
4	1	8.33	12	100.00

OriginalDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
3	6	50.00	7	58.33
4	4	33.33	11	91.67
5	1	8.33	12	100.00

UseSpecialEffects	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	4	33.33	5	41.67
3	4	33.33	9	75.00
4	2	16.67	11	91.67
5	1	8.33	12	100.00

FascinatingDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	6	50.00	8	66.67
3	4	33.33	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

Use2016DesignPrinciples	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	6	50.00	10	83.33
4	2	16.67	12	100.00

UsingHeroImage	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	25.00	3	25.00
2	1	8.33	4	33.33
3	5	41.67	9	75.00
4	2	16.67	11	91.67
5	1	8.33	12	100.00

UseLongScroll	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	25.00	3	25.00
2	2	16.67	5	41.67
3	6	50.00	11	91.67
4	1	8.33	12	100.00

LayoutEasyToGrasp	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
3	2	16.67	3	25.00
4	5	41.67	8	66.67
5	4	33.33	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

SiteGoesTogether	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	16.67	2	16.67
3	6	50.00	8	66.67
4	3	25.00	11	91.67
5	1	8.33	12	100.00

Layout_WellStructured	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
3	3	25.00	4	33.33
4	7	58.33	11	91.67
5	1	8.33	12	100.00

Layout_PleasantlyVaried	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	1	8.33	2	16.67
3	4	33.33	6	50.00
4	6	50.00	12	100.00

Layout_Inventive	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	4	33.33	5	41.67
3	3	25.00	8	66.67
4	4	33.33	12	100.00

Layout_EasyToNavigate	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
3	3	25.00	4	33.33
4	5	41.67	9	75.00
5	3	25.00	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

BoldDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	16.67	2	16.67
3	6	50.00	8	66.67
4	1	8.33	9	75.00
5	3	25.00	12	100.00

Layout_Dynamic	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	8.33	1	8.33
2	3	25.00	4	33.33
3	7	58.33	11	91.67
5	1	8.33	12	100.00

Attractive	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	25.00	3	25.00
2	2	16.67	5	41.67
3	5	41.67	10	83.33
4	2	16.67	12	100.00

AppropriateAgeGroup_13_17_	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	2	16.67	6	50.00
4	4	33.33	10	83.33
5	2	16.67	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The FREQ Procedure

Appealing	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	4	33.33	8	66.67
4	4	33.33	12	100.00

Layout_Professional	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	5	41.67	9	75.00
4	1	8.33	10	83.33
5	2	16.67	12	100.00

Layout_UpToDate_2016DesignTechni	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	6	50.00	10	83.33
4	1	8.33	11	91.67
5	1	8.33	12	100.00

DesignedWithCare	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	16.67	2	16.67
2	2	16.67	4	33.33
3	5	41.67	9	75.00
4	2	16.67	11	91.67
5	1	8.33	12	100.00

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Simple_NaturalDialogue

Moments			
N	12	**Sum Weights**	12
Mean	3.41666667	**Sum Observations**	41
Std Deviation	1.08362467	**Variance**	1.17424242
Skewness	-0.0011907	**Kurtosis**	-1.1526993
Uncorrected SS	153	**Corrected SS**	12.9166667
Coeff Variation	31.715844	**Std Error Mean**	0.3128155

Basic Statistical Measures			
Location		**Variability**	
Mean	3.416667	**Std Deviation**	1.08362
Median	3.500000	**Variance**	1.17424
Mode	4.000000	**Range**	3.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.331989	**Pr > |t|**	0.2098
Sign	**M**	1.5	**Pr >= |M|**	0.5078
Signed Rank	**S**	10.5	**Pr >= |S|**	0.2578

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.890109	**Pr < W**	0.1182
Kolmogorov-Smirnov	**D**	0.204821	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.08343	**Pr > W-Sq**	0.1741
Anderson-Darling	**A-Sq**	0.536151	**Pr > A-Sq**	0.1378

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Simple_NaturalDialogue

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.0
50% Median	3.5
25% Q1	2.5
10%	2.0
5%	2.0
1%	2.0
0% Min	2.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	11	4	6
2	10	4	7
2	2	4	12
3	9	5	5
3	4	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Consistency

Moments			
N	12	**Sum Weights**	12
Mean	3.33333333	**Sum Observations**	40
Std Deviation	1.07308674	**Variance**	1.15151515
Skewness	0.25504388	**Kurtosis**	-0.9963989
Uncorrected SS	146	**Corrected SS**	12.6666667
Coeff Variation	32.1926022	**Std Error Mean**	0.30977346

Basic Statistical Measures			
Location		**Variability**	
Mean	3.333333	**Std Deviation**	1.07309
Median	3.000000	**Variance**	1.15152
Mode	3.000000	**Range**	3.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.076055	**Pr > |t|**	0.3049
Sign	**M**	1	**Pr >= |M|**	0.7266
Signed Rank	**S**	7.5	**Pr >= |S|**	0.3438

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.891492	**Pr < W**	0.1232
Kolmogorov-Smirnov	**D**	0.205293	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.082719	**Pr > W-Sq**	0.1784
Anderson-Darling	**A-Sq**	0.524104	**Pr > A-Sq**	0.1471

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Consistency

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.0
50% Median	3.0
25% Q1	2.5
10%	2.0
5%	2.0
1%	2.0
0% Min	2.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	11	4	1
2	7	4	4
2	2	4	12
3	10	5	5
3	9	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AffordancesMappings_Constraints

Moments			
N	12	**Sum Weights**	12
Mean	3.33333333	**Sum Observations**	40
Std Deviation	1.23091491	**Variance**	1.51515152
Skewness	-0.4159508	**Kurtosis**	-0.4488
Uncorrected SS	150	**Corrected SS**	16.6666667
Coeff Variation	36.9274473	**Std Error Mean**	0.35533453

Basic Statistical Measures			
Location		**Variability**	
Mean	3.333333	**Std Deviation**	1.23091
Median	3.500000	**Variance**	1.51515
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.938083	**Pr > |t|**	0.3683
Sign	**M**	1.5	**Pr >= |M|**	0.5078
Signed Rank	**S**	7.5	**Pr >= |S|**	0.4805

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.930561	**Pr < W**	0.3861
Kolmogorov-Smirnov	**D**	0.205954	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.071368	**Pr > W-Sq**	0.2480
Anderson-Darling	**A-Sq**	0.40811	**Pr > A-Sq**	>0.2500

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AffordancesMappings_Constraints

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.0
50% Median	3.5
25% Q1	2.5
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	4	3
2	7	4	6
2	2	4	12
3	10	5	5
3	9	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SpeakUsersLanguage

Moments			
N	12	Sum Weights	12
Mean	3.91666667	Sum Observations	47
Std Deviation	0.66855792	Variance	0.4469697
Skewness	0.08619615	Kurtosis	-0.1896007
Uncorrected SS	189	Corrected SS	4.91666667
Coeff Variation	17.069564	Std Error Mean	0.19299605

Basic Statistical Measures			
Location		Variability	
Mean	3.916667	Std Deviation	0.66856
Median	4.000000	Variance	0.44697
Mode	4.000000	Range	2.00000
		Interquartile Range	0.50000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	4.749665	Pr > |t|	0.0006
Sign	M	4.5	Pr >= |M|	0.0039
Signed Rank	S	22.5	Pr >= |S|	0.0039

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.809145	Pr < W	0.0119
Kolmogorov-Smirnov	D	0.299598	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.225842	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.151709	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SpeakUsersLanguage

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.0
50% Median	4.0
25% Q1	3.5
10%	3.0
5%	3.0
1%	3.0
0% Min	3.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	9	4	10
3	6	4	11
3	2	4	12
4	12	5	5
4	11	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Wonderful

Moments			
N	12	**Sum Weights**	12
Mean	2.75	**Sum Observations**	33
Std Deviation	0.62158156	**Variance**	0.38636364
Skewness	0.17034346	**Kurtosis**	-0.0913495
Uncorrected SS	95	**Corrected SS**	4.25
Coeff Variation	22.6029658	**Std Error Mean**	0.17943514

Basic Statistical Measures			
Location		**Variability**	
Mean	2.750000	**Std Deviation**	0.62158
Median	3.000000	**Variance**	0.38636
Mode	3.000000	**Range**	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.39326	**Pr > |t|**	0.1911
Sign	**M**	-1.5	**Pr >= |M|**	0.3750
Signed Rank	**S**	-4.5	**Pr >= |S|**	0.3750

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.780112	**Pr < W**	0.0056
Kolmogorov-Smirnov	**D**	0.322898	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.254502	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.355343	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Wonderful

Quantiles (Definition 5)	
Level	**Quantile**
90%	3
75% Q3	3
50% Median	3
25% Q1	2
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	12	3	6
2	11	3	7
2	8	3	9
2	2	3	10
3	10	4	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Easy

Moments			
N	12	**Sum Weights**	12
Mean	4	**Sum Observations**	48
Std Deviation	1.04446594	**Variance**	1.09090909
Skewness	-0.5744563	**Kurtosis**	-0.8555556
Uncorrected SS	204	**Corrected SS**	12
Coeff Variation	26.1116484	**Std Error Mean**	0.30151134

Basic Statistical Measures			
Location		**Variability**	
Mean	4.000000	**Std Deviation**	1.04447
Median	4.000000	**Variance**	1.09091
Mode	5.000000	**Range**	3.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	3.316625	**Pr > |t|**	0.0069
Sign	**M**	3.5	**Pr >= |M|**	0.0391
Signed Rank	**S**	20	**Pr >= |S|**	0.0195

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.846239	**Pr < W**	0.0330
Kolmogorov-Smirnov	**D**	0.247491	**Pr > D**	0.0414
Cramer-von Mises	**W-Sq**	0.121835	**Pr > W-Sq**	0.0490
Anderson-Darling	**A-Sq**	0.781852	**Pr > A-Sq**	0.0312

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Easy

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	3
10%	3
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	12	5	2
3	11	5	3
3	9	5	4
3	1	5	8
4	7	5	10

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Stimulating

Moments			
N	12	**Sum Weights**	12
Mean	2.5	**Sum Observations**	30
Std Deviation	1	**Variance**	1
Skewness	0	**Kurtosis**	-0.7636364
Uncorrected SS	86	**Corrected SS**	11
Coeff Variation	40	**Std Error Mean**	0.28867513

Basic Statistical Measures			
Location		**Variability**	
Mean	2.500000	**Std Deviation**	1.00000
Median	2.500000	**Variance**	1.00000
Mode	2.000000	**Range**	3.00000
		Interquartile Range	1.00000

Note: The mode displayed is the smallest of 2 modes with a count of 4.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.73205	**Pr > |t|**	0.1112
Sign	**M**	-2	**Pr >= |M|**	0.2891
Signed Rank	**S**	-11	**Pr >= |S|**	0.1719

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.905608	**Pr < W**	0.1874
Kolmogorov-Smirnov	**D**	0.191462	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.089344	**Pr > W-Sq**	0.1420
Anderson-Darling	**A-Sq**	0.517973	**Pr > A-Sq**	0.1528

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Stimulating

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4.0
99%	4.0
95%	4.0
90%	4.0
75% Q3	3.0
50% Median	2.5
25% Q1	2.0
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	3	3
1	2	3	7
2	12	3	9
2	10	4	4
2	8	4	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Satisfying

Moments			
N	12	Sum Weights	12
Mean	2.83333333	Sum Observations	34
Std Deviation	0.83484711	Variance	0.6969697
Skewness	-0.7707738	Kurtosis	1.14782609
Uncorrected SS	104	Corrected SS	7.66666667
Coeff Variation	29.4651921	Std Error Mean	0.2409996

Basic Statistical Measures			
Location		Variability	
Mean	2.833333	Std Deviation	0.83485
Median	3.000000	Variance	0.69697
Mode	3.000000	Range	3.00000
		Interquartile Range	0.50000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.69156	Pr > |t|	0.5035
Sign	M	-0.5	Pr >= |M|	1.0000
Signed Rank	S	-2.5	Pr >= |S|	0.7500

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.842839	Pr < W	0.0300
Kolmogorov-Smirnov	D	0.329118	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.219039	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.028518	Pr > A-Sq	0.0070

Quantiles (Definition 5)	
Level	Quantile
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Satisfying

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	3.0
50% Median	3.0
25% Q1	2.5
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	10	3	7
2	12	3	8
2	11	3	9
3	9	4	3
3	8	4	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Flexible

Moments			
N	12	**Sum Weights**	12
Mean	2.75	**Sum Observations**	33
Std Deviation	0.75377836	**Variance**	0.56818182
Skewness	-1.0507067	**Kurtosis**	2.06037333
Uncorrected SS	97	**Corrected SS**	6.25
Coeff Variation	27.4101222	**Std Error Mean**	0.21759707

Basic Statistical Measures			
Location		**Variability**	
Mean	2.750000	**Std Deviation**	0.75378
Median	3.000000	**Variance**	0.56818
Mode	3.000000	**Range**	3.00000
		Interquartile Range	0.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.14891	**Pr > |t|**	0.2750
Sign	**M**	-1	**Pr >= |M|**	0.6250
Signed Rank	**S**	-3	**Pr >= |S|**	0.5000

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.781047	**Pr < W**	0.0058
Kolmogorov-Smirnov	**D**	0.379928	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.320587	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.493109	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Flexible

Quantiles (Definition 5)	
Level	**Quantile**
90%	3.0
75% Q3	3.0
50% Median	3.0
25% Q1	2.5
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	3	8
2	12	3	9
2	3	3	10
3	11	3	11
3	10	4	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: ClearDesign

Moments			
N	12	**Sum Weights**	12
Mean	3.16666667	**Sum Observations**	38
Std Deviation	1.11464086	**Variance**	1.24242424
Skewness	-1.3304077	**Kurtosis**	0.76168947
Uncorrected SS	134	**Corrected SS**	13.6666667
Coeff Variation	35.199185	**Std Error Mean**	0.3217691

Basic Statistical Measures			
Location		**Variability**	
Mean	3.166667	**Std Deviation**	1.11464
Median	3.500000	**Variance**	1.24242
Mode	4.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.51797	**Pr > |t|**	0.6147
Sign	**M**	2	**Pr >= |M|**	0.2891
Signed Rank	**S**	3	**Pr >= |S|**	0.7969

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.728904	**Pr < W**	0.0016
Kolmogorov-Smirnov	**D**	0.273903	**Pr > D**	0.0141
Cramer-von Mises	**W-Sq**	0.222329	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.362317	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: ClearDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	4.0
50% Median	3.5
25% Q1	3.0
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	4	3
1	2	4	4
3	12	4	5
3	10	4	6
3	9	4	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AestheticDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.25	**Sum Observations**	27
Std Deviation	0.8660254	**Variance**	0.75
Skewness	0.44088566	**Kurtosis**	0.23434343
Uncorrected SS	69	**Corrected SS**	8.25
Coeff Variation	38.4900179	**Std Error Mean**	0.25

Basic Statistical Measures			
Location		**Variability**	
Mean	2.250000	**Std Deviation**	0.86603
Median	2.000000	**Variance**	0.75000
Mode	2.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-3	**Pr > |t|**	0.0121
Sign	**M**	-3.5	**Pr >= |M|**	0.0391
Signed Rank	**S**	-18.5	**Pr >= |S|**	0.0313

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.884197	**Pr < W**	0.0992
Kolmogorov-Smirnov	**D**	0.280252	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.152566	**Pr > W-Sq**	0.0195
Anderson-Darling	**A-Sq**	0.758905	**Pr > A-Sq**	0.0363

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AestheticDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	3
75% Q3	3
50% Median	2
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	2	12
1	2	3	6
2	12	3	9
2	8	3	10
2	7	4	1

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: PleasantDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.58333333	**Sum Observations**	31
Std Deviation	0.99620492	**Variance**	0.99242424
Skewness	-0.2743235	**Kurtosis**	-0.6538081
Uncorrected SS	91	**Corrected SS**	10.9166667
Coeff Variation	38.5627711	**Std Error Mean**	0.28757959

Basic Statistical Measures			
Location		**Variability**	
Mean	2.583333	**Std Deviation**	0.99620
Median	3.000000	**Variance**	0.99242
Mode	3.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.44887	**Pr > |t|**	0.1753
Sign	**M**	-1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	-8	**Pr >= |S|**	0.2500

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.895047	**Pr < W**	0.1369
Kolmogorov-Smirnov	**D**	0.245453	**Pr > D**	0.0446
Cramer-von Mises	**W-Sq**	0.10615	**Pr > W-Sq**	0.0851
Anderson-Darling	**A-Sq**	0.590485	**Pr > A-Sq**	0.0977

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: PleasantDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	3	9
1	2	3	10
2	8	3	12
2	7	4	1
2	5	4	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CleanDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.83333333	**Sum Observations**	34
Std Deviation	1.11464086	**Variance**	1.24242424
Skewness	0.38511803	**Kurtosis**	-0.0549673
Uncorrected SS	110	**Corrected SS**	13.6666667
Coeff Variation	39.3402656	**Std Error Mean**	0.3217691

Basic Statistical Measures			
Location		**Variability**	
Mean	2.833333	**Std Deviation**	1.11464
Median	3.000000	**Variance**	1.24242
Mode	2.000000	**Range**	4.00000
		Interquartile Range	1.50000

Note: The mode displayed is the smallest of 2 modes with a count of 4.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.51797	**Pr > |t|**	0.6147
Sign	**M**	-1	**Pr >= |M|**	0.7266
Signed Rank	**S**	-3.5	**Pr >= |S|**	0.7891

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.935297	**Pr < W**	0.4396
Kolmogorov-Smirnov	**D**	0.19057	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.085241	**Pr > W-Sq**	0.1630
Anderson-Darling	**A-Sq**	0.463427	**Pr > A-Sq**	0.2174

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CleanDesign

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0
90%	4.0
75% Q3	3.5
50% Median	3.0
25% Q1	2.0
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	3	9
2	12	3	10
2	11	4	1
2	5	4	4
2	3	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SymmetricDesign

Moments			
N	12	**Sum Weights**	12
Mean	3.33333333	**Sum Observations**	40
Std Deviation	0.98473193	**Variance**	0.96969697
Skewness	-0.8124038	**Kurtosis**	2.371875
Uncorrected SS	144	**Corrected SS**	10.6666667
Coeff Variation	29.5419578	**Std Error Mean**	0.28426762

Basic Statistical Measures			
Location		**Variability**	
Mean	3.333333	**Std Deviation**	0.98473
Median	3.000000	**Variance**	0.96970
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.172604	**Pr > |t|**	0.2657
Sign	**M**	2	**Pr >= |M|**	0.2188
Signed Rank	**S**	5	**Pr >= |S|**	0.4063

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.848327	**Pr < W**	0.0350
Kolmogorov-Smirnov	**D**	0.284159	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.171284	**Pr > W-Sq**	0.0099
Anderson-Darling	**A-Sq**	0.924696	**Pr > A-Sq**	0.0135

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SymmetricDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	3
25% Q1	3
10%	3
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	4	1
3	10	4	3
3	9	4	11
3	7	4	12
3	6	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CreativeDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.75	**Sum Observations**	33
Std Deviation	0.8660254	**Variance**	0.75
Skewness	-0.4408857	**Kurtosis**	0.23434343
Uncorrected SS	99	**Corrected SS**	8.25
Coeff Variation	31.4918329	**Std Error Mean**	0.25

Basic Statistical Measures			
Location		**Variability**	
Mean	2.750000	**Std Deviation**	0.86603
Median	3.000000	**Variance**	0.75000
Mode	3.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1	**Pr > |t|**	0.3388
Sign	**M**	-1	**Pr >= |M|**	0.6875
Signed Rank	**S**	-4.5	**Pr >= |S|**	0.5313

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.884197	**Pr < W**	0.0992
Kolmogorov-Smirnov	**D**	0.280252	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.152566	**Pr > W-Sq**	0.0195
Anderson-Darling	**A-Sq**	0.758905	**Pr > A-Sq**	0.0363

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CreativeDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	3
25% Q1	2
10%	2
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	3	9
2	11	3	10
2	6	3	12
2	3	4	1
3	12	4	5

The UNIVARIATE Procedure
Variable: SophisticatedDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.33333333	**Sum Observations**	28
Std Deviation	0.88762536	**Variance**	0.78787879
Skewness	0.13865864	**Kurtosis**	-0.2538462
Uncorrected SS	74	**Corrected SS**	8.66666667
Coeff Variation	38.0410871	**Std Error Mean**	0.25623537

Basic Statistical Measures			
Location		**Variability**	
Mean	2.333333	**Std Deviation**	0.88763
Median	2.000000	**Variance**	0.78788
Mode	2.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-2.60177	**Pr > |t|**	0.0246
Sign	**M**	-3	**Pr >= |M|**	0.0703
Signed Rank	**S**	-14.5	**Pr >= |S|**	0.0547

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.900272	**Pr < W**	0.1599
Kolmogorov-Smirnov	**D**	0.229702	**Pr > D**	0.0798
Cramer-von Mises	**W-Sq**	0.119808	**Pr > W-Sq**	0.0527
Anderson-Darling	**A-Sq**	0.642969	**Pr > A-Sq**	0.0743

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

The UNIVARIATE Procedure
Variable: SophisticatedDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	3
75% Q3	3
50% Median	2
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	3	1
1	2	3	7
2	11	3	9
2	8	3	10
2	6	4	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: OriginalDesign

Moments			
N	12	**Sum Weights**	12
Mean	3.33333333	**Sum Observations**	40
Std Deviation	0.98473193	**Variance**	0.96969697
Skewness	-0.8124038	**Kurtosis**	2.371875
Uncorrected SS	144	**Corrected SS**	10.6666667
Coeff Variation	29.5419578	**Std Error Mean**	0.28426762

Basic Statistical Measures			
Location		**Variability**	
Mean	3.333333	**Std Deviation**	0.98473
Median	3.000000	**Variance**	0.96970
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.172604	**Pr > |t|**	0.2657
Sign	**M**	2	**Pr >= |M|**	0.2188
Signed Rank	**S**	5	**Pr >= |S|**	0.4063

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.848327	**Pr < W**	0.0350
Kolmogorov-Smirnov	**D**	0.284159	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.171284	**Pr > W-Sq**	0.0099
Anderson-Darling	**A-Sq**	0.924696	**Pr > A-Sq**	0.0135

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: OriginalDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	3
25% Q1	3
10%	3
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	4	1
3	10	4	4
3	9	4	5
3	8	4	12
3	7	5	11

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseSpecialEffects

Moments			
N	12	**Sum Weights**	12
Mean	2.83333333	**Sum Observations**	34
Std Deviation	1.11464086	**Variance**	1.24242424
Skewness	0.38511803	**Kurtosis**	-0.0549673
Uncorrected SS	110	**Corrected SS**	13.6666667
Coeff Variation	39.3402656	**Std Error Mean**	0.3217691

Basic Statistical Measures			
Location		**Variability**	
Mean	2.833333	**Std Deviation**	1.11464
Median	3.000000	**Variance**	1.24242
Mode	2.000000	**Range**	4.00000
		Interquartile Range	1.50000

Note: The mode displayed is the smallest of 2 modes with a count of 4.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.51797	**Pr > |t|**	0.6147
Sign	**M**	-1	**Pr >= |M|**	0.7266
Signed Rank	**S**	-3.5	**Pr >= |S|**	0.7891

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.935297	**Pr < W**	0.4396
Kolmogorov-Smirnov	**D**	0.19057	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.085241	**Pr > W-Sq**	0.1630
Anderson-Darling	**A-Sq**	0.463427	**Pr > A-Sq**	0.2174

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseSpecialEffects

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0
90%	4.0
75% Q3	3.5
50% Median	3.0
25% Q1	2.0
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	3	9
2	12	3	10
2	11	4	5
2	6	4	8
2	4	5	1

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: FascinatingDesign

Moments			
N	12	**Sum Weights**	12
Mean	2.16666667	**Sum Observations**	26
Std Deviation	0.71774056	**Variance**	0.51515152
Skewness	-0.2622609	**Kurtosis**	-0.6851211
Uncorrected SS	62	**Corrected SS**	5.66666667
Coeff Variation	33.1264875	**Std Error Mean**	0.20719385

Basic Statistical Measures			
Location		**Variability**	
Mean	2.166667	**Std Deviation**	0.71774
Median	2.000000	**Variance**	0.51515
Mode	2.000000	**Range**	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-4.022	**Pr > |t|**	0.0020
Sign	**M**	-4	**Pr >= |M|**	0.0078
Signed Rank	**S**	-18	**Pr >= |S|**	0.0078

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.818335	**Pr < W**	0.0153
Kolmogorov-Smirnov	**D**	0.258479	**Pr > D**	0.0248
Cramer-von Mises	**W-Sq**	0.176751	**Pr > W-Sq**	0.0087
Anderson-Darling	**A-Sq**	1.003027	**Pr > A-Sq**	0.0081

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	3
99%	3
95%	3

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: FascinatingDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	3
75% Q3	3
50% Median	2
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	2	12
1	2	3	4
2	12	3	7
2	8	3	9
2	6	3	10

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Use2016DesignPrinciples

Moments			
N	12	Sum Weights	12
Mean	2.66666667	Sum Observations	32
Std Deviation	0.98473193	Variance	0.96969697
Skewness	-0.5585276	Kurtosis	-0.309375
Uncorrected SS	96	Corrected SS	10.6666667
Coeff Variation	36.9274473	Std Error Mean	0.28426762

Basic Statistical Measures			
Location		Variability	
Mean	2.666667	Std Deviation	0.98473
Median	3.000000	Variance	0.96970
Mode	3.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-1.1726	Pr > |t|	0.2657
Sign	M	-1	Pr >= |M|	0.6875
Signed Rank	S	-5.5	Pr >= |S|	0.3438

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.862662	Pr < W	0.0528
Kolmogorov-Smirnov	D	0.299174	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.156337	Pr > W-Sq	0.0176
Anderson-Darling	A-Sq	0.810468	Pr > A-Sq	0.0249

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Use2016DesignPrinciples

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	3	9
1	2	3	10
2	6	3	11
2	5	4	1
3	11	4	4

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UsingHeroImage

Moments			
N	12	Sum Weights	12
Mean	2.75	Sum Observations	33
Std Deviation	1.28805703	Variance	1.65909091
Skewness	-0.0574296	Kurtosis	-0.6566836
Uncorrected SS	109	Corrected SS	18.25
Coeff Variation	46.8384374	Std Error Mean	0.37183004

Basic Statistical Measures			
Location		Variability	
Mean	2.750000	Std Deviation	1.28806
Median	3.000000	Variance	1.65909
Mode	3.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.67235	Pr > |t|	0.5152
Sign	M	-0.5	Pr >= |M|	1.0000
Signed Rank	S	-4.5	Pr >= |S|	0.5625

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.898747	Pr < W	0.1528
Kolmogorov-Smirnov	D	0.243614	Pr > D	0.0474
Cramer-von Mises	W-Sq	0.10441	Pr > W-Sq	0.0892
Anderson-Darling	A-Sq	0.587535	Pr > A-Sq	0.0990

Quantiles (Definition 5)	
Level	Quantile
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UsingHeroImage

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	3.5
50% Median	3.0
25% Q1	1.5
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	8	3	10
1	2	3	11
1	1	4	4
2	7	4	12
3	11	5	3

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseLongScroll

Moments			
N	12	Sum Weights	12
Mean	2.41666667	Sum Observations	29
Std Deviation	0.99620492	Variance	0.99242424
Skewness	-0.387731	Kurtosis	-0.9737894
Uncorrected SS	81	Corrected SS	10.9166667
Coeff Variation	41.2222725	Std Error Mean	0.28757959

Basic Statistical Measures			
Location		Variability	
Mean	2.416667	Std Deviation	0.99620
Median	3.000000	Variance	0.99242
Mode	3.000000	Range	3.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-2.02842	Pr > |t|	0.0674
Sign	M	-2	Pr >= |M|	0.2188
Signed Rank	S	-8.5	Pr >= |S|	0.1250

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.839785	Pr < W	0.0275
Kolmogorov-Smirnov	D	0.304246	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.170503	Pr > W-Sq	0.0102
Anderson-Darling	A-Sq	0.961312	Pr > A-Sq	0.0099

Quantiles (Definition 5)	
Level	Quantile
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseLongScroll

Quantiles (Definition 5)	
Level	**Quantile**
90%	3.0
75% Q3	3.0
50% Median	3.0
25% Q1	1.5
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	8	3	6
1	2	3	9
1	1	3	10
2	7	3	12
2	3	4	11

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: LayoutEasyToGrasp

Moments			
N	12	**Sum Weights**	12
Mean	3.91666667	**Sum Observations**	47
Std Deviation	1.16450015	**Variance**	1.35606061
Skewness	-1.4689689	**Kurtosis**	2.76103742
Uncorrected SS	199	**Corrected SS**	14.9166667
Coeff Variation	29.7319188	**Std Error Mean**	0.33616224

Basic Statistical Measures			
Location		**Variability**	
Mean	3.916667	**Std Deviation**	1.16450
Median	4.000000	**Variance**	1.35606
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	2.726858	**Pr > |t|**	0.0197
Sign	**M**	4	**Pr >= |M|**	0.0215
Signed Rank	**S**	19.5	**Pr >= |S|**	0.0410

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.813193	**Pr < W**	0.0133
Kolmogorov-Smirnov	**D**	0.278525	**Pr > D**	0.0109
Cramer-von Mises	**W-Sq**	0.145624	**Pr > W-Sq**	0.0232
Anderson-Darling	**A-Sq**	0.871024	**Pr > A-Sq**	0.0189

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: LayoutEasyToGrasp

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	5.0
50% Median	4.0
25% Q1	3.5
10%	3.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	4	12
3	10	5	1
3	9	5	2
4	12	5	3
4	7	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SiteGoesTogether

Moments			
N	12	Sum Weights	12
Mean	3.25	Sum Observations	39
Std Deviation	0.8660254	Variance	0.75
Skewness	0.44088566	Kurtosis	0.23434343
Uncorrected SS	135	Corrected SS	8.25
Coeff Variation	26.6469355	Std Error Mean	0.25

Basic Statistical Measures			
Location		Variability	
Mean	3.250000	Std Deviation	0.86603
Median	3.000000	Variance	0.75000
Mode	3.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	1	Pr > |t|	0.3388
Sign	M	1	Pr >= |M|	0.6875
Signed Rank	S	4.5	Pr >= |S|	0.5313

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.884197	Pr < W	0.0992
Kolmogorov-Smirnov	D	0.280252	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.152566	Pr > W-Sq	0.0195
Anderson-Darling	A-Sq	0.758905	Pr > A-Sq	0.0363

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SiteGoesTogether

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	3
25% Q1	3
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	7	3	10
2	5	4	4
3	10	4	11
3	9	4	12
3	6	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_WellStructured

Moments			
N	12	Sum Weights	12
Mean	3.58333333	Sum Observations	43
Std Deviation	0.99620492	Variance	0.99242424
Skewness	-1.5984326	Kurtosis	3.82593089
Uncorrected SS	165	Corrected SS	10.9166667
Coeff Variation	27.8010675	Std Error Mean	0.28757959

Basic Statistical Measures			
Location		Variability	
Mean	3.583333	Std Deviation	0.99620
Median	4.000000	Variance	0.99242
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	2.028424	Pr > |t|	0.0674
Sign	M	3.5	Pr >= |M|	0.0391
Signed Rank	S	14	Pr >= |S|	0.1211

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.778752	Pr < W	0.0054
Kolmogorov-Smirnov	D	0.328786	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.242588	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.276544	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_WellStructured

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	3
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	4	5
3	10	4	7
3	9	4	11
3	6	4	12
4	12	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_PleasantlyVaried

Moments			
N	12	**Sum Weights**	12
Mean	3.25	**Sum Observations**	39
Std Deviation	0.9653073	**Variance**	0.93181818
Skewness	-1.3189279	**Kurtosis**	1.4082094
Uncorrected SS	137	**Corrected SS**	10.25
Coeff Variation	29.7017631	**Std Error Mean**	0.27866021

Basic Statistical Measures			
Location		**Variability**	
Mean	3.250000	**Std Deviation**	0.96531
Median	3.500000	**Variance**	0.93182
Mode	4.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.89715	**Pr > |t|**	0.3889
Sign	**M**	2	**Pr >= |M|**	0.2891
Signed Rank	**S**	6	**Pr >= |S|**	0.5625

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.777846	**Pr < W**	0.0053
Kolmogorov-Smirnov	**D**	0.281407	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.187506	**Pr > W-Sq**	0.0062
Anderson-Darling	**A-Sq**	1.109841	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_PleasantlyVaried

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	4.0
50% Median	3.5
25% Q1	3.0
10%	2.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	4	3
2	11	4	4
3	10	4	5
3	9	4	7
3	8	4	12

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Inventive

Moments			
N	12	Sum Weights	12
Mean	2.83333333	Sum Observations	34
Std Deviation	1.0298573	Variance	1.06060606
Skewness	-0.2108475	Kurtosis	-1.1422041
Uncorrected SS	108	Corrected SS	11.6666667
Coeff Variation	36.3479047	Std Error Mean	0.2972942

Basic Statistical Measures			
Location		Variability	
Mean	2.833333	Std Deviation	1.02986
Median	3.000000	Variance	1.06061
Mode	2.000000	Range	3.00000
		Interquartile Range	2.00000

Note: The mode displayed is the smallest of 2 modes with a count of 4.

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.56061	Pr > |t|	0.5863
Sign	M	-0.5	Pr >= |M|	1.0000
Signed Rank	S	-4.5	Pr >= |S|	0.7813

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.870417	Pr < W	0.0662
Kolmogorov-Smirnov	D	0.207459	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.104269	Pr > W-Sq	0.0895
Anderson-Darling	A-Sq	0.680606	Pr > A-Sq	0.0575

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Inventive

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4
90%	4
75% Q3	4
50% Median	3
25% Q1	2
10%	2
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
1	2	3	10
2	12	4	1
2	11	4	4
2	6	4	5
2	3	4	7

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_EasyToNavigate

Moments			
N	12	**Sum Weights**	12
Mean	3.75	**Sum Observations**	45
Std Deviation	1.13818037	**Variance**	1.29545455
Skewness	-1.19304	**Kurtosis**	2.11535857
Uncorrected SS	183	**Corrected SS**	14.25
Coeff Variation	30.3514764	**Std Error Mean**	0.32856437

Basic Statistical Measures			
Location		**Variability**	
Mean	3.750000	**Std Deviation**	1.13818
Median	4.000000	**Variance**	1.29545
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	2.282658	**Pr > |t|**	0.0433
Sign	**M**	3.5	**Pr >= |M|**	0.0391
Signed Rank	**S**	15	**Pr >= |S|**	0.0781

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.851237	**Pr < W**	0.0380
Kolmogorov-Smirnov	**D**	0.253594	**Pr > D**	0.0320
Cramer-von Mises	**W-Sq**	0.122443	**Pr > W-Sq**	0.0482
Anderson-Darling	**A-Sq**	0.727804	**Pr > A-Sq**	0.0433

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_EasyToNavigate

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.5
50% Median	4.0
25% Q1	3.0
10%	3.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	4	6
3	11	4	7
3	10	5	2
3	9	5	3
4	7	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: BoldDesign

Moments			
N	12	**Sum Weights**	12
Mean	3.41666667	**Sum Observations**	41
Std Deviation	1.08362467	**Variance**	1.17424242
Skewness	0.51321186	**Kurtosis**	-0.9241374
Uncorrected SS	153	**Corrected SS**	12.9166667
Coeff Variation	31.715844	**Std Error Mean**	0.3128155

Basic Statistical Measures			
Location		**Variability**	
Mean	3.416667	**Std Deviation**	1.08362
Median	3.000000	**Variance**	1.17424
Mode	3.000000	**Range**	3.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.331989	**Pr > |t|**	0.2098
Sign	**M**	1	**Pr >= |M|**	0.6875
Signed Rank	**S**	6.5	**Pr >= |S|**	0.2188

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.826814	**Pr < W**	0.0192
Kolmogorov-Smirnov	**D**	0.316367	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.181003	**Pr > W-Sq**	0.0077
Anderson-Darling	**A-Sq**	0.987486	**Pr > A-Sq**	0.0088

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: BoldDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.5
50% Median	3.0
25% Q1	3.0
10%	2.0
5%	2.0
1%	2.0
0% Min	2.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	12	3	10
2	1	4	11
3	10	5	2
3	9	5	5
3	7	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Dynamic

Moments			
N	12	**Sum Weights**	12
Mean	2.75	**Sum Observations**	33
Std Deviation	0.9653073	**Variance**	0.93181818
Skewness	0.59124354	**Kurtosis**	2.49708507
Uncorrected SS	101	**Corrected SS**	10.25
Coeff Variation	35.1020836	**Std Error Mean**	0.27866021

Basic Statistical Measures			
Location		**Variability**	
Mean	2.750000	**Std Deviation**	0.96531
Median	3.000000	**Variance**	0.93182
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.89715	**Pr > |t|**	0.3889
Sign	**M**	-1.5	**Pr >= |M|**	0.3750
Signed Rank	**S**	-3	**Pr >= |S|**	0.5625

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.829403	**Pr < W**	0.0206
Kolmogorov-Smirnov	**D**	0.31449	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.220296	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.101005	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Dynamic

Quantiles (Definition 5)	
Level	**Quantile**
90%	3
75% Q3	3
50% Median	3
25% Q1	2
10%	2
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	2	3	8
2	11	3	9
2	3	3	10
2	1	3	12
3	12	5	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Attractive

Moments			
N	12	**Sum Weights**	12
Mean	2.5	**Sum Observations**	30
Std Deviation	1.08711461	**Variance**	1.18181818
Skewness	-0.2547322	**Kurtosis**	-1.1282051
Uncorrected SS	88	**Corrected SS**	13
Coeff Variation	43.4845845	**Std Error Mean**	0.31382296

Basic Statistical Measures			
Location		**Variability**	
Mean	2.500000	**Std Deviation**	1.08711
Median	3.000000	**Variance**	1.18182
Mode	3.000000	**Range**	3.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.59326	**Pr > |t|**	0.1394
Sign	**M**	-1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	-9	**Pr >= |S|**	0.1719

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.868633	**Pr < W**	0.0628
Kolmogorov-Smirnov	**D**	0.260551	**Pr > D**	0.0233
Cramer-von Mises	**W-Sq**	0.116165	**Pr > W-Sq**	0.0614
Anderson-Darling	**A-Sq**	0.689747	**Pr > A-Sq**	0.0535

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4.0
99%	4.0
95%	4.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Attractive

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	3.0
50% Median	3.0
25% Q1	1.5
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	3	9
1	8	3	10
1	2	3	12
2	7	4	1
2	6	4	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
*Variable: AppropriateAgeGroup_13_17_*

Moments			
N	12	**Sum Weights**	12
Mean	3.16666667	**Sum Observations**	38
Std Deviation	1.40345893	**Variance**	1.96969697
Skewness	-0.3507817	**Kurtosis**	-1.0966154
Uncorrected SS	142	**Corrected SS**	21.6666667
Coeff Variation	44.3197557	**Std Error Mean**	0.4051437

Basic Statistical Measures			
Location		**Variability**	
Mean	3.166667	**Std Deviation**	1.40346
Median	3.500000	**Variance**	1.96970
Mode	4.000000	**Range**	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.411377	**Pr > |t|**	0.6887
Sign	**M**	1	**Pr >= |M|**	0.7539
Signed Rank	**S**	3.5	**Pr >= |S|**	0.8281

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.905611	**Pr < W**	0.1874
Kolmogorov-Smirnov	**D**	0.223667	**Pr > D**	0.0944
Cramer-von Mises	**W-Sq**	0.076866	**Pr > W-Sq**	0.2143
Anderson-Darling	**A-Sq**	0.47097	**Pr > A-Sq**	0.2085

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
*Variable: AppropriateAgeGroup_13_17_*

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	4.0
50% Median	3.5
25% Q1	2.0
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	4	2
1	11	4	3
2	8	4	5
2	7	5	4
3	10	5	6

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Appealing

Moments			
N	12	**Sum Weights**	12
Mean	2.83333333	**Sum Observations**	34
Std Deviation	1.11464086	**Variance**	1.24242424
Skewness	-0.5601717	**Kurtosis**	-0.871624
Uncorrected SS	110	**Corrected SS**	13.6666667
Coeff Variation	39.3402656	**Std Error Mean**	0.3217691

Basic Statistical Measures			
Location		**Variability**	
Mean	2.833333	**Std Deviation**	1.11464
Median	3.000000	**Variance**	1.24242
Mode	3.000000	**Range**	3.00000
		Interquartile Range	2.00000

Note: The mode displayed is the smallest of 2 modes with a count of 4.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.51797	**Pr > |t|**	0.6147
Sign	**M**	0	**Pr >= |M|**	1.0000
Signed Rank	**S**	-4	**Pr >= |S|**	0.5547

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.859258	**Pr < W**	0.0479
Kolmogorov-Smirnov	**D**	0.226097	**Pr > D**	0.0885
Cramer-von Mises	**W-Sq**	0.102159	**Pr > W-Sq**	0.0945
Anderson-Darling	**A-Sq**	0.659409	**Pr > A-Sq**	0.0670

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Appealing

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4
90%	4
75% Q3	4
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	11	3	10
1	2	4	1
2	8	4	3
2	7	4	5
3	10	4	12

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Professional

Moments			
N	12	**Sum Weights**	12
Mean	2.91666667	**Sum Observations**	35
Std Deviation	1.31137217	**Variance**	1.71969697
Skewness	0.18073009	**Kurtosis**	-0.4390693
Uncorrected SS	121	**Corrected SS**	18.9166667
Coeff Variation	44.9613316	**Std Error Mean**	0.37856054

Basic Statistical Measures			
Location		**Variability**	
Mean	2.916667	**Std Deviation**	1.31137
Median	3.000000	**Variance**	1.71970
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.22013	**Pr > |t|**	0.8298
Sign	**M**	-0.5	**Pr >= |M|**	1.0000
Signed Rank	**S**	-1	**Pr >= |S|**	1.0000

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.909559	**Pr < W**	0.2106
Kolmogorov-Smirnov	**D**	0.224666	**Pr > D**	0.0920
Cramer-von Mises	**W-Sq**	0.090021	**Pr > W-Sq**	0.1393
Anderson-Darling	**A-Sq**	0.49866	**Pr > A-Sq**	0.1757

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Professional

Quantiles (Definition 5)	
Level	**Quantile**
90%	5.0
75% Q3	3.5
50% Median	3.0
25% Q1	2.0
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	3	10
1	2	3	11
2	5	4	4
2	3	5	1
3	11	5	8

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_UpToDate_2016DesignTechni

Moments			
N	12	Sum Weights	12
Mean	2.75	Sum Observations	33
Std Deviation	1.13818037	Variance	1.29545455
Skewness	0.13872558	Kurtosis	0.42523853
Uncorrected SS	105	Corrected SS	14.25
Coeff Variation	41.3883769	Std Error Mean	0.32856437

Basic Statistical Measures			
Location		Variability	
Mean	2.750000	Std Deviation	1.13818
Median	3.000000	Variance	1.29545
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.76089	Pr > |t|	0.4627
Sign	M	-1	Pr >= |M|	0.6875
Signed Rank	S	-3.5	Pr >= |S|	0.6250

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.899833	Pr < W	0.1578
Kolmogorov-Smirnov	D	0.253594	Pr > D	0.0320
Cramer-von Mises	W-Sq	0.13688	Pr > W-Sq	0.0312
Anderson-Darling	A-Sq	0.67361	Pr > A-Sq	0.0606

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_UpToDate_2016DesignTechni

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	3	9
1	2	3	10
2	8	3	11
2	5	4	4
3	11	5	1

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: DesignedWithCare

Moments			
N	12	Sum Weights	12
Mean	2.83333333	Sum Observations	34
Std Deviation	1.19341628	Variance	1.42424242
Skewness	-0.0071313	Kurtosis	-0.2031689
Uncorrected SS	112	Corrected SS	15.6666667
Coeff Variation	42.1205747	Std Error Mean	0.34450961

Basic Statistical Measures			
Location		Variability	
Mean	2.833333	Std Deviation	1.19342
Median	3.000000	Variance	1.42424
Mode	3.000000	Range	4.00000
		Interquartile Range	1.50000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.48378	Pr > |t|	0.6380
Sign	M	-0.5	Pr >= |M|	1.0000
Signed Rank	S	-3	Pr >= |S|	0.7656

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.929193	Pr < W	0.3716
Kolmogorov-Smirnov	D	0.2222	Pr > D	0.0980
Cramer-von Mises	W-Sq	0.08883	Pr > W-Sq	0.1441
Anderson-Darling	A-Sq	0.461851	Pr > A-Sq	0.2193

Quantiles (Definition 5)	
Level	Quantile
100% Max	5.0
99%	5.0
95%	5.0

Usability Data Analysis - (ChemiNet App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: DesignedWithCare

Quantiles (Definition 5)	
Level	**Quantile**
90%	4.0
75% Q3	3.5
50% Median	3.0
25% Q1	2.0
10%	1.0
5%	1.0
1%	1.0
0% Min	1.0

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	12	3	9
1	2	3	10
2	11	4	4
2	5	4	6
3	10	5	1

APPENDIX M (80 pages)

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

Simple_NaturalDialogue	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	4	44.44	6	66.67
5	3	33.33	9	100.00

Consistency	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	1	11.11	2	22.22
4	3	33.33	5	55.56
5	4	44.44	9	100.00

AffordancesMappings_Constraints	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	6	66.67	8	88.89
5	1	11.11	9	100.00

SpeakUsersLanguage	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	4	44.44	6	66.67
5	3	33.33	9	100.00

Wonderful	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	1	11.11	3	33.33
4	4	44.44	7	77.78
5	2	22.22	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

Easy	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	4	44.44	5	55.56
4	1	11.11	6	66.67
5	3	33.33	9	100.00

Stimulating	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	3	33.33	4	44.44
3	1	11.11	5	55.56
4	2	22.22	7	77.78
5	2	22.22	9	100.00

Satisfying	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	2	22.22	4	44.44
4	3	33.33	7	77.78
5	2	22.22	9	100.00

Flexible	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	2	22.22	3	33.33
3	2	22.22	5	55.56
4	2	22.22	7	77.78
5	2	22.22	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

ClearDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	1	11.11	1	11.11
4	5	55.56	6	66.67
5	3	33.33	9	100.00

AestheticDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	2	22.22	4	44.44
4	3	33.33	7	77.78
5	2	22.22	9	100.00

PleasantDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	11.11	1	11.11
3	1	11.11	2	22.22
4	5	55.56	7	77.78
5	2	22.22	9	100.00

CleanDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	1	11.11	1	11.11
4	5	55.56	6	66.67
5	3	33.33	9	100.00

SymmetricDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	6	66.67	8	88.89
5	1	11.11	9	100.00

The FREQ Procedure

CreativeDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	22.22	2	22.22
3	3	33.33	5	55.56
4	4	44.44	9	100.00

SophisticatedDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	4	44.44	4	44.44
3	1	11.11	5	55.56
4	3	33.33	8	88.89
5	1	11.11	9	100.00

OriginalDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	1	11.11	3	33.33
4	5	55.56	8	88.89
5	1	11.11	9	100.00

UseSpecialEffects	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	22.22	2	22.22
3	3	33.33	5	55.56
4	2	22.22	7	77.78
5	2	22.22	9	100.00

FascinatingDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	22.22	2	22.22
3	2	22.22	4	44.44
4	5	55.56	9	100.00

The FREQ Procedure

Use2016DesignPrinciples	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	3	33.33	4	44.44
4	5	55.56	9	100.00

UsingHeroImage	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	22.22	2	22.22
3	5	55.56	7	77.78
4	1	11.11	8	88.89
5	1	11.11	9	100.00

UseLongScroll	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	5	55.56	7	77.78
4	2	22.22	9	100.00

LayoutEasyToGrasp	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	11.11	1	11.11
3	1	11.11	2	22.22
4	5	55.56	7	77.78
5	2	22.22	9	100.00

SiteGoesTogether	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	11.11	1	11.11
3	3	33.33	4	44.44
4	3	33.33	7	77.78
5	2	22.22	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

Layout_WellStructured	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	6	66.67	8	88.89
5	1	11.11	9	100.00

Layout_PleasantlyVaried	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	2	22.22	3	33.33
4	6	66.67	9	100.00

Layout_Inventive	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	2	22.22	4	44.44
4	5	55.56	9	100.00

Layout_EasyToNavigate	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	1	11.11	1	11.11
4	5	55.56	6	66.67
5	3	33.33	9	100.00

BoldDesign	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	33.33	3	33.33
2	2	22.22	5	55.56
3	2	22.22	7	77.78
4	2	22.22	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

Layout_Dynamic	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	22.22	2	22.22
2	2	22.22	4	44.44
3	1	11.11	5	55.56
4	4	44.44	9	100.00

Attractive	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	3	33.33	3	33.33
4	6	66.67	9	100.00

AppropriateAgeGroup_13_17_	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
2	1	11.11	2	22.22
3	2	22.22	4	44.44
4	3	33.33	7	77.78
5	2	22.22	9	100.00

Appealing	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	22.22	2	22.22
4	5	55.56	7	77.78
5	2	22.22	9	100.00

Layout_Professional	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	22.22	2	22.22
3	2	22.22	4	44.44
4	5	55.56	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The FREQ Procedure

Layout_UpToDate_2016DesignTechni	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	22.22	2	22.22
3	2	22.22	4	44.44
4	4	44.44	8	88.89
5	1	11.11	9	100.00

DesignedWithCare	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	11.11	1	11.11
3	3	33.33	4	44.44
4	3	33.33	7	77.78
5	2	22.22	9	100.00

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Simple_NaturalDialogue

Moments			
N	9	**Sum Weights**	9
Mean	4.11111111	**Sum Observations**	37
Std Deviation	0.78173596	**Variance**	0.61111111
Skewness	-0.2159696	**Kurtosis**	-1.0413223
Uncorrected SS	157	**Corrected SS**	4.88888889
Coeff Variation	19.015199	**Std Error Mean**	0.26057865

Basic Statistical Measures			
Location		**Variability**	
Mean	4.111111	**Std Deviation**	0.78174
Median	4.000000	**Variance**	0.61111
Mode	4.000000	**Range**	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	4.264014	**Pr > |t|**	0.0027
Sign	**M**	3.5	**Pr >= |M|**	0.0156
Signed Rank	**S**	14	**Pr >= |S|**	0.0156

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.837984	**Pr < W**	0.0548
Kolmogorov-Smirnov	**D**	0.22318	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.108643	**Pr > W-Sq**	0.0757
Anderson-Darling	**A-Sq**	0.660045	**Pr > A-Sq**	0.0577

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Simple_NaturalDialogue

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	6
3	1	4	8
4	8	5	3
4	6	5	7
4	5	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Consistency

Moments			
N	9	**Sum Weights**	9
Mean	4	**Sum Observations**	36
Std Deviation	1.32287566	**Variance**	1.75
Skewness	-1.6661291	**Kurtosis**	2.95043732
Uncorrected SS	158	**Corrected SS**	14
Coeff Variation	33.0718914	**Std Error Mean**	0.44095855

Basic Statistical Measures			
Location		**Variability**	
Mean	4.000000	**Std Deviation**	1.32288
Median	4.000000	**Variance**	1.75000
Mode	5.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	2.267787	**Pr > |t|**	0.0531
Sign	**M**	3	**Pr >= |M|**	0.0703
Signed Rank	**S**	12	**Pr >= |S|**	0.1016

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.776209	**Pr < W**	0.0109
Kolmogorov-Smirnov	**D**	0.277778	**Pr > D**	0.0441
Cramer-von Mises	**W-Sq**	0.138054	**Pr > W-Sq**	0.0276
Anderson-Darling	**A-Sq**	0.835317	**Pr > A-Sq**	0.0199

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Consistency

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	6
3	4	5	3
4	6	5	7
4	2	5	8
4	1	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AffordancesMappings_Constraints

Moments			
N	9	**Sum Weights**	9
Mean	3.88888889	**Sum Observations**	35
Std Deviation	0.60092521	**Variance**	0.36111111
Skewness	-0.0182868	**Kurtosis**	1.12595097
Uncorrected SS	139	**Corrected SS**	2.88888889
Coeff Variation	15.4523626	**Std Error Mean**	0.2003084

Basic Statistical Measures			
Location		**Variability**	
Mean	3.888889	**Std Deviation**	0.60093
Median	4.000000	**Variance**	0.36111
Mode	4.000000	**Range**	2.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	4.437602	**Pr > |t|**	0.0022
Sign	**M**	3.5	**Pr >= |M|**	0.0156
Signed Rank	**S**	14	**Pr >= |S|**	0.0156

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.780526	**Pr < W**	0.0122
Kolmogorov-Smirnov	**D**	0.351124	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.23738	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.135896	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AffordancesMappings_Constraints

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	5	4	3
3	4	4	6
4	8	4	7
4	7	4	8
4	6	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SpeakUsersLanguage

Moments			
N	9	Sum Weights	9
Mean	4.11111111	Sum Observations	37
Std Deviation	0.78173596	Variance	0.61111111
Skewness	-0.2159696	Kurtosis	-1.0413223
Uncorrected SS	157	Corrected SS	4.88888889
Coeff Variation	19.015199	Std Error Mean	0.26057865

Basic Statistical Measures			
Location		Variability	
Mean	4.111111	Std Deviation	0.78174
Median	4.000000	Variance	0.61111
Mode	4.000000	Range	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	4.264014	Pr > |t|	0.0027
Sign	M	3.5	Pr >= |M|	0.0156
Signed Rank	S	14	Pr >= |S|	0.0156

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.837984	Pr < W	0.0548
Kolmogorov-Smirnov	D	0.22318	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.108643	Pr > W-Sq	0.0757
Anderson-Darling	A-Sq	0.660045	Pr > A-Sq	0.0577

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SpeakUsersLanguage

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
3	5	4	3
3	4	4	6
4	6	5	7
4	3	5	8
4	2	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Wonderful

Moments			
N	9	**Sum Weights**	9
Mean	3.55555556	**Sum Observations**	32
Std Deviation	1.33333333	**Variance**	1.77777778
Skewness	-0.9659598	**Kurtosis**	0.29882813
Uncorrected SS	128	**Corrected SS**	14.2222222
Coeff Variation	37.5	**Std Error Mean**	0.44444444

Basic Statistical Measures			
Location		**Variability**	
Mean	3.555556	**Std Deviation**	1.33333
Median	4.000000	**Variance**	1.77778
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.25	**Pr > |t|**	0.2466
Sign	**M**	2	**Pr >= |M|**	0.2891
Signed Rank	**S**	8	**Pr >= |S|**	0.3438

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.874011	**Pr < W**	0.1357
Kolmogorov-Smirnov	**D**	0.297225	**Pr > D**	0.0216
Cramer-von Mises	**W-Sq**	0.107741	**Pr > W-Sq**	0.0779
Anderson-Darling	**A-Sq**	0.56821	**Pr > A-Sq**	0.0999

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Wonderful

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	6
2	9	4	7
3	1	4	8
4	8	5	3
4	7	5	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Easy

Moments			
N	9	**Sum Weights**	9
Mean	3.55555556	**Sum Observations**	32
Std Deviation	1.33333333	**Variance**	1.77777778
Skewness	-0.5591518	**Kurtosis**	0.18582589
Uncorrected SS	128	**Corrected SS**	14.2222222
Coeff Variation	37.5	**Std Error Mean**	0.44444444

Basic Statistical Measures			
Location		**Variability**	
Mean	3.555556	**Std Deviation**	1.33333
Median	3.000000	**Variance**	1.77778
Mode	3.000000	**Range**	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.25	**Pr > |t|**	0.2466
Sign	**M**	1.5	**Pr >= |M|**	0.3750
Signed Rank	**S**	4	**Pr >= |S|**	0.3750

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.858699	**Pr < W**	0.0928
Kolmogorov-Smirnov	**D**	0.22735	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.099184	**Pr > W-Sq**	0.0984
Anderson-Darling	**A-Sq**	0.603489	**Pr > A-Sq**	0.0837

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Easy

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	3
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	3	8
3	8	4	6
3	4	5	3
3	2	5	7
3	1	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Stimulating

Moments			
N	9	**Sum Weights**	9
Mean	3.11111111	**Sum Observations**	28
Std Deviation	1.45296631	**Variance**	2.11111111
Skewness	0.07115338	**Kurtosis**	-1.4976256
Uncorrected SS	104	**Corrected SS**	16.8888889
Coeff Variation	46.7024887	**Std Error Mean**	0.4843221

Basic Statistical Measures			
Location		**Variability**	
Mean	3.111111	**Std Deviation**	1.45297
Median	3.000000	**Variance**	2.11111
Mode	2.000000	**Range**	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.229416	**Pr > |t|**	0.8243
Sign	**M**	0	**Pr >= |M|**	1.0000
Signed Rank	**S**	2	**Pr >= |S|**	0.8828

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.907097	**Pr < W**	0.2961
Kolmogorov-Smirnov	**D**	0.222225	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.065139	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.40429	**Pr > A-Sq**	>0.2500

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Stimulating

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	3	4
2	9	4	2
2	8	4	6
2	1	5	3
3	4	5	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Satisfying

Moments			
N	9	**Sum Weights**	9
Mean	3.44444444	**Sum Observations**	31
Std Deviation	1.33333333	**Variance**	1.77777778
Skewness	-0.6612723	**Kurtosis**	-0.1531808
Uncorrected SS	121	**Corrected SS**	14.2222222
Coeff Variation	38.7096774	**Std Error Mean**	0.44444444

Basic Statistical Measures			
Location		**Variability**	
Mean	3.444444	**Std Deviation**	1.33333
Median	4.000000	**Variance**	1.77778
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1	**Pr > |t|**	0.3466
Sign	**M**	1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	5.5	**Pr >= |S|**	0.4688

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.921805	**Pr < W**	0.4074
Kolmogorov-Smirnov	**D**	0.217094	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.057995	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.346641	**Pr > A-Sq**	>0.2500

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Satisfying

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	4	2
2	1	4	6
3	5	4	8
3	4	5	3
4	8	5	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Flexible

Moments			
N	9	**Sum Weights**	9
Mean	3.22222222	**Sum Observations**	29
Std Deviation	1.39443338	**Variance**	1.94444444
Skewness	-0.1463545	**Kurtosis**	-1.0600583
Uncorrected SS	109	**Corrected SS**	15.5555556
Coeff Variation	43.2755186	**Std Error Mean**	0.46481113

Basic Statistical Measures			
Location		**Variability**	
Mean	3.222222	**Std Deviation**	1.39443
Median	3.000000	**Variance**	1.94444
Mode	2.000000	**Range**	4.00000
		Interquartile Range	2.00000

Note: The mode displayed is the smallest of 4 modes with a count of 2.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.478091	**Pr > |t|**	0.6454
Sign	**M**	0.5	**Pr >= |M|**	1.0000
Signed Rank	**S**	3	**Pr >= |S|**	0.7656

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.937564	**Pr < W**	0.5565
Kolmogorov-Smirnov	**D**	0.155945	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.040317	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.271455	**Pr > A-Sq**	>0.2500

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Flexible

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5
90%	5
75% Q3	4
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	3	4
2	9	4	2
2	8	4	6
3	4	5	3
3	1	5	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: ClearDesign

Moments			
N	9	Sum Weights	9
Mean	4.22222222	Sum Observations	38
Std Deviation	0.66666667	Variance	0.44444444
Skewness	-0.2544643	Kurtosis	-0.0401786
Uncorrected SS	164	Corrected SS	3.55555556
Coeff Variation	15.7894737	Std Error Mean	0.22222222

Basic Statistical Measures			
Location		Variability	
Mean	4.222222	Std Deviation	0.66667
Median	4.000000	Variance	0.44444
Mode	4.000000	Range	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	5.5	Pr > |t|	0.0006
Sign	M	4	Pr >= |M|	0.0078
Signed Rank	S	18	Pr >= |S|	0.0078

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.812592	Pr < W	0.0284
Kolmogorov-Smirnov	D	0.297225	Pr > D	0.0216
Cramer-von Mises	W-Sq	0.165864	Pr > W-Sq	0.0115
Anderson-Darling	A-Sq	0.887535	Pr > A-Sq	0.0145

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: ClearDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	6
4	9	4	9
4	6	5	3
4	5	5	7
4	2	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AestheticDesign

Moments			
N	9	Sum Weights	9
Mean	3.44444444	Sum Observations	31
Std Deviation	1.33333333	Variance	1.77777778
Skewness	-0.6612723	Kurtosis	-0.1531808
Uncorrected SS	121	Corrected SS	14.2222222
Coeff Variation	38.7096774	Std Error Mean	0.44444444

Basic Statistical Measures			
Location		Variability	
Mean	3.444444	Std Deviation	1.33333
Median	4.000000	Variance	1.77778
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	1	Pr > |t|	0.3466
Sign	M	1.5	Pr >= |M|	0.4531
Signed Rank	S	5.5	Pr >= |S|	0.4688

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.921805	Pr < W	0.4074
Kolmogorov-Smirnov	D	0.217094	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.057995	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.346641	Pr > A-Sq	>0.2500

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AestheticDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	4	2
2	1	4	5
3	8	4	6
3	4	5	3
4	6	5	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: PleasantDesign

Moments			
N	9	**Sum Weights**	9
Mean	3.88888889	**Sum Observations**	35
Std Deviation	0.92796073	**Variance**	0.86111111
Skewness	-0.9435486	**Kurtosis**	1.35394678
Uncorrected SS	143	**Corrected SS**	6.88888889
Coeff Variation	23.8618473	**Std Error Mean**	0.30932024

Basic Statistical Measures			
Location		**Variability**	
Mean	3.888889	**Std Deviation**	0.92796
Median	4.000000	**Variance**	0.86111
Mode	4.000000	**Range**	3.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	2.873685	**Pr > |t|**	0.0207
Sign	**M**	3	**Pr >= |M|**	0.0703
Signed Rank	**S**	14.5	**Pr >= |S|**	0.0547

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.846311	**Pr < W**	0.0679
Kolmogorov-Smirnov	**D**	0.325432	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.15149	**Pr > W-Sq**	0.0190
Anderson-Darling	**A-Sq**	0.743663	**Pr > A-Sq**	0.0347

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: PleasantDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	1	4	6
3	4	4	7
4	9	4	9
4	7	5	3
4	6	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CleanDesign

Moments			
N	9	Sum Weights	9
Mean	4.22222222	Sum Observations	38
Std Deviation	0.66666667	Variance	0.44444444
Skewness	-0.2544643	Kurtosis	-0.0401786
Uncorrected SS	164	Corrected SS	3.55555556
Coeff Variation	15.7894737	Std Error Mean	0.22222222

Basic Statistical Measures			
Location		Variability	
Mean	4.222222	Std Deviation	0.66667
Median	4.000000	Variance	0.44444
Mode	4.000000	Range	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	5.5	Pr > |t|	0.0006
Sign	M	4	Pr >= |M|	0.0078
Signed Rank	S	18	Pr >= |S|	0.0078

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.812592	Pr < W	0.0284
Kolmogorov-Smirnov	D	0.297225	Pr > D	0.0216
Cramer-von Mises	W-Sq	0.165864	Pr > W-Sq	0.0115
Anderson-Darling	A-Sq	0.887535	Pr > A-Sq	0.0145

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CleanDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	6
4	9	4	9
4	6	5	3
4	5	5	7
4	2	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SymmetricDesign

Moments			
N	9	**Sum Weights**	9
Mean	3.88888889	**Sum Observations**	35
Std Deviation	0.60092521	**Variance**	0.36111111
Skewness	-0.0182868	**Kurtosis**	1.12595097
Uncorrected SS	139	**Corrected SS**	2.88888889
Coeff Variation	15.4523626	**Std Error Mean**	0.2003084

Basic Statistical Measures			
Location		**Variability**	
Mean	3.888889	**Std Deviation**	0.60093
Median	4.000000	**Variance**	0.36111
Mode	4.000000	**Range**	2.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	4.437602	**Pr > |t|**	0.0022
Sign	**M**	3.5	**Pr >= |M|**	0.0156
Signed Rank	**S**	14	**Pr >= |S|**	0.0156

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.780526	**Pr < W**	0.0122
Kolmogorov-Smirnov	**D**	0.351124	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.23738	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.135896	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SymmetricDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	5
3	1	4	6
4	9	4	7
4	7	4	9
4	6	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CreativeDesign

Moments			
N	9	Sum Weights	9
Mean	3.22222222	Sum Observations	29
Std Deviation	0.83333333	Variance	0.69444444
Skewness	-0.5005714	Kurtosis	-1.2754286
Uncorrected SS	99	Corrected SS	5.55555556
Coeff Variation	25.862069	Std Error Mean	0.27777778

Basic Statistical Measures			
Location		Variability	
Mean	3.222222	Std Deviation	0.83333
Median	3.000000	Variance	0.69444
Mode	4.000000	Range	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	0.8	Pr > |t|	0.4468
Sign	M	1	Pr >= |M|	0.6875
Signed Rank	S	3.5	Pr >= |S|	0.6875

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.808361	Pr < W	0.0254
Kolmogorov-Smirnov	D	0.26912	Pr > D	0.0593
Cramer-von Mises	W-Sq	0.113937	Pr > W-Sq	0.0630
Anderson-Darling	A-Sq	0.741567	Pr > A-Sq	0.0351

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: CreativeDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	3
25% Q1	3
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	9	3	8
2	5	4	2
3	8	4	3
3	4	4	6
3	1	4	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SophisticatedDesign

Moments			
N	9	**Sum Weights**	9
Mean	3.11111111	**Sum Observations**	28
Std Deviation	1.16666667	**Variance**	1.36111111
Skewness	0.33985839	**Kurtosis**	-1.578628
Uncorrected SS	98	**Corrected SS**	10.8888889
Coeff Variation	37.5	**Std Error Mean**	0.38888889

Basic Statistical Measures			
Location		**Variability**	
Mean	3.111111	**Std Deviation**	1.16667
Median	3.000000	**Variance**	1.36111
Mode	2.000000	**Range**	3.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.285714	**Pr > |t|**	0.7824
Sign	**M**	0	**Pr >= |M|**	1.0000
Signed Rank	**S**	2	**Pr >= |S|**	1.0000

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.82714	**Pr < W**	0.0415
Kolmogorov-Smirnov	**D**	0.273993	**Pr > D**	0.0492
Cramer-von Mises	**W-Sq**	0.11683	**Pr > W-Sq**	0.0561
Anderson-Darling	**A-Sq**	0.72377	**Pr > A-Sq**	0.0392

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SophisticatedDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	3
25% Q1	2
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	9	3	4
2	8	4	2
2	5	4	6
2	1	4	7
3	4	5	3

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: OriginalDesign

Moments			
N	9	**Sum Weights**	9
Mean	3.44444444	**Sum Observations**	31
Std Deviation	1.23603308	**Variance**	1.52777778
Skewness	-1.1137431	**Kurtosis**	0.75655254
Uncorrected SS	119	**Corrected SS**	12.2222222
Coeff Variation	35.8848314	**Std Error Mean**	0.41201103

Basic Statistical Measures			
Location		**Variability**	
Mean	3.444444	**Std Deviation**	1.23603
Median	4.000000	**Variance**	1.52778
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.07872	**Pr > |t|**	0.3122
Sign	**M**	2	**Pr >= |M|**	0.2891
Signed Rank	**S**	7	**Pr >= |S|**	0.4375

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.838544	**Pr < W**	0.0556
Kolmogorov-Smirnov	**D**	0.340119	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.164254	**Pr > W-Sq**	0.0123
Anderson-Darling	**A-Sq**	0.818305	**Pr > A-Sq**	0.0216

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: OriginalDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	3
2	1	4	6
3	4	4	7
4	9	4	9
4	7	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseSpecialEffects

Moments			
N	9	**Sum Weights**	9
Mean	3.22222222	**Sum Observations**	29
Std Deviation	1.48136574	**Variance**	2.19444444
Skewness	-0.4846219	**Kurtosis**	-0.7062055
Uncorrected SS	111	**Corrected SS**	17.5555556
Coeff Variation	45.9734194	**Std Error Mean**	0.49378858

Basic Statistical Measures			
Location		**Variability**	
Mean	3.222222	**Std Deviation**	1.48137
Median	3.000000	**Variance**	2.19444
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	0.450035	**Pr > |t|**	0.6646
Sign	**M**	1	**Pr >= |M|**	0.6875
Signed Rank	**S**	1.5	**Pr >= |S|**	0.8125

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.886536	**Pr < W**	0.1838
Kolmogorov-Smirnov	**D**	0.218155	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.066634	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.442831	**Pr > A-Sq**	0.2258

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseSpecialEffects

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	3
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	3	8
1	5	4	3
3	8	4	6
3	4	5	2
3	1	5	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: FascinatingDesign

Moments			
N	9	Sum Weights	9
Mean	3.11111111	Sum Observations	28
Std Deviation	1.26929552	Variance	1.61111111
Skewness	-1.2031033	Kurtosis	-0.1498216
Uncorrected SS	100	Corrected SS	12.8888889
Coeff Variation	40.7987845	Std Error Mean	0.42309851

Basic Statistical Measures			
Location		Variability	
Mean	3.111111	Std Deviation	1.26930
Median	4.000000	Variance	1.61111
Mode	4.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	0.262613	Pr > |t|	0.7995
Sign	M	1.5	Pr >= |M|	0.4531
Signed Rank	S	1	Pr >= |S|	1.0000

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.713311	Pr < W	0.0020
Kolmogorov-Smirnov	D	0.313686	Pr > D	0.0115
Cramer-von Mises	W-Sq	0.194177	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.15541	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: FascinatingDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	4	1
1	5	4	2
3	8	4	3
3	4	4	6
4	7	4	7

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Use2016DesignPrinciples

Moments			
N	9	**Sum Weights**	9
Mean	3.33333333	**Sum Observations**	30
Std Deviation	1	**Variance**	1
Skewness	-1.8214286	**Kurtosis**	3.64285714
Uncorrected SS	108	**Corrected SS**	8
Coeff Variation	30	**Std Error Mean**	0.33333333

Basic Statistical Measures			
Location		**Variability**	
Mean	3.333333	**Std Deviation**	1.00000
Median	4.000000	**Variance**	1.00000
Mode	4.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1	**Pr > |t|**	0.3466
Sign	**M**	2	**Pr >= |M|**	0.2188
Signed Rank	**S**	4.5	**Pr >= |S|**	0.5313

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.710164	**Pr < W**	0.0019
Kolmogorov-Smirnov	**D**	0.303063	**Pr > D**	0.0181
Cramer-von Mises	**W-Sq**	0.187903	**Pr > W-Sq**	0.0056
Anderson-Darling	**A-Sq**	1.115313	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Use2016DesignPrinciples

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	2
3	8	4	3
3	4	4	6
3	1	4	7
4	9	4	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UsingHeroImage

Moments			
N	9	Sum Weights	9
Mean	2.88888889	Sum Observations	26
Std Deviation	1.26929552	Variance	1.61111111
Skewness	-0.2115133	Kurtosis	0.26295227
Uncorrected SS	88	Corrected SS	12.8888889
Coeff Variation	43.9371525	Std Error Mean	0.42309851

Basic Statistical Measures			
Location		Variability	
Mean	2.888889	Std Deviation	1.26930
Median	3.000000	Variance	1.61111
Mode	3.000000	Range	4.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.26261	Pr > |t|	0.7995
Sign	M	0	Pr >= |M|	1.0000
Signed Rank	S	-1	Pr >= |S|	1.0000

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.859065	Pr < W	0.0937
Kolmogorov-Smirnov	D	0.312656	Pr > D	0.0122
Cramer-von Mises	W-Sq	0.149259	Pr > W-Sq	0.0202
Anderson-Darling	A-Sq	0.735318	Pr > A-Sq	0.0366

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UsingHeroImage

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	3
50% Median	3
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	3	7
1	1	3	8
3	9	3	9
3	8	4	6
3	7	5	3

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseLongScroll

Moments			
N	9	Sum Weights	9
Mean	2.88888889	Sum Observations	26
Std Deviation	0.92796073	Variance	0.86111111
Skewness	-0.9435486	Kurtosis	1.35394678
Uncorrected SS	82	Corrected SS	6.88888889
Coeff Variation	32.1217175	Std Error Mean	0.30932024

Basic Statistical Measures			
Location		Variability	
Mean	2.888889	Std Deviation	0.92796
Median	3.000000	Variance	0.86111
Mode	3.000000	Range	3.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	-0.35921	Pr > |t|	0.7287
Sign	M	0	Pr >= |M|	1.0000
Signed Rank	S	-1	Pr >= |S|	1.0000

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.846311	Pr < W	0.0679
Kolmogorov-Smirnov	D	0.325432	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.15149	Pr > W-Sq	0.0190
Anderson-Darling	A-Sq	0.743663	Pr > A-Sq	0.0347

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: UseLongScroll

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	3
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	3	4
2	1	3	7
3	9	3	9
3	7	4	6
3	4	4	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: LayoutEasyToGrasp

Moments			
N	9	**Sum Weights**	9
Mean	3.88888889	**Sum Observations**	35
Std Deviation	0.92796073	**Variance**	0.86111111
Skewness	-0.9435486	**Kurtosis**	1.35394678
Uncorrected SS	143	**Corrected SS**	6.88888889
Coeff Variation	23.8618473	**Std Error Mean**	0.30932024

Basic Statistical Measures			
Location		**Variability**	
Mean	3.888889	**Std Deviation**	0.92796
Median	4.000000	**Variance**	0.86111
Mode	4.000000	**Range**	3.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	2.873685	**Pr > |t|**	0.0207
Sign	**M**	3	**Pr >= |M|**	0.0703
Signed Rank	**S**	14.5	**Pr >= |S|**	0.0547

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.846311	**Pr < W**	0.0679
Kolmogorov-Smirnov	**D**	0.325432	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.15149	**Pr > W-Sq**	0.0190
Anderson-Darling	**A-Sq**	0.743663	**Pr > A-Sq**	0.0347

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: LayoutEasyToGrasp

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	3	4	5
3	4	4	6
4	8	4	8
4	6	5	7
4	5	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SiteGoesTogether

Moments			
N	9	Sum Weights	9
Mean	3.66666667	Sum Observations	33
Std Deviation	1	Variance	1
Skewness	-0.1071429	Kurtosis	-0.6428571
Uncorrected SS	129	Corrected SS	8
Coeff Variation	27.2727273	Std Error Mean	0.33333333

Basic Statistical Measures			
Location		Variability	
Mean	3.666667	Std Deviation	1.00000
Median	4.000000	Variance	1.00000
Mode	3.000000	Range	3.00000
		Interquartile Range	1.00000

Note: The mode displayed is the smallest of 2 modes with a count of 3.

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	2	Pr > |t|	0.0805
Sign	M	2	Pr >= |M|	0.2188
Signed Rank	S	8	Pr >= |S|	0.1563

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.916548	Pr < W	0.3644
Kolmogorov-Smirnov	D	0.191952	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.06872	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.404031	Pr > A-Sq	>0.2500

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: SiteGoesTogether

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	8	4	2
3	7	4	5
3	4	4	6
3	1	5	3
4	6	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_WellStructured

Moments			
N	9	Sum Weights	9
Mean	3.88888889	Sum Observations	35
Std Deviation	0.60092521	Variance	0.36111111
Skewness	-0.0182868	Kurtosis	1.12595097
Uncorrected SS	139	Corrected SS	2.88888889
Coeff Variation	15.4523626	Std Error Mean	0.2003084

Basic Statistical Measures			
Location		Variability	
Mean	3.888889	Std Deviation	0.60093
Median	4.000000	Variance	0.36111
Mode	4.000000	Range	2.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	4.437602	Pr > |t|	0.0022
Sign	M	3.5	Pr >= |M|	0.0156
Signed Rank	S	14	Pr >= |S|	0.0156

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.780526	Pr < W	0.0122
Kolmogorov-Smirnov	D	0.351124	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.23738	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.135896	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_WellStructured

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	5
3	1	4	6
4	9	4	7
4	7	4	9
4	6	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_PleasantlyVaried

Moments			
N	9	Sum Weights	9
Mean	3.44444444	Sum Observations	31
Std Deviation	1.01379376	Variance	1.02777778
Skewness	-2.1213182	Kurtosis	4.64697903
Uncorrected SS	115	Corrected SS	8.22222222
Coeff Variation	29.4327219	Std Error Mean	0.33793125

Basic Statistical Measures			
Location		Variability	
Mean	3.444444	Std Deviation	1.01379
Median	4.000000	Variance	1.02778
Mode	4.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	1.315192	Pr > |t|	0.2249
Sign	M	2.5	Pr >= |M|	0.1250
Signed Rank	S	7	Pr >= |S|	0.3594

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.636924	Pr < W	0.0003
Kolmogorov-Smirnov	D	0.37482	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.267544	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	1.471592	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_PleasantlyVaried

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	3
3	4	4	6
3	1	4	7
4	9	4	8
4	8	4	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Inventive

Moments			
N	9	Sum Weights	9
Mean	3.22222222	Sum Observations	29
Std Deviation	1.09290642	Variance	1.19444444
Skewness	-1.2888916	Kurtosis	0.77045507
Uncorrected SS	103	Corrected SS	9.55555556
Coeff Variation	33.9177855	Std Error Mean	0.36430214

Basic Statistical Measures			
Location		Variability	
Mean	3.222222	Std Deviation	1.09291
Median	4.000000	Variance	1.19444
Mode	4.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	0.609994	Pr > |t|	0.5588
Sign	M	1.5	Pr >= |M|	0.4531
Signed Rank	S	3.5	Pr >= |S|	0.7656

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.767343	Pr < W	0.0086
Kolmogorov-Smirnov	D	0.317218	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.16391	Pr > W-Sq	0.0125
Anderson-Darling	A-Sq	0.938659	Pr > A-Sq	0.0097

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Inventive

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
1	5	4	2
2	9	4	3
3	4	4	6
3	1	4	7
4	8	4	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_EasyToNavigate

Moments			
N	9	**Sum Weights**	9
Mean	4.22222222	**Sum Observations**	38
Std Deviation	0.66666667	**Variance**	0.44444444
Skewness	-0.2544643	**Kurtosis**	-0.0401786
Uncorrected SS	164	**Corrected SS**	3.55555556
Coeff Variation	15.7894737	**Std Error Mean**	0.22222222

Basic Statistical Measures			
Location		**Variability**	
Mean	4.222222	**Std Deviation**	0.66667
Median	4.000000	**Variance**	0.44444
Mode	4.000000	**Range**	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	5.5	**Pr > |t|**	0.0006
Sign	**M**	4	**Pr >= |M|**	0.0078
Signed Rank	**S**	18	**Pr >= |S|**	0.0078

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.812592	**Pr < W**	0.0284
Kolmogorov-Smirnov	**D**	0.297225	**Pr > D**	0.0216
Cramer-von Mises	**W-Sq**	0.165864	**Pr > W-Sq**	0.0115
Anderson-Darling	**A-Sq**	0.887535	**Pr > A-Sq**	0.0145

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_EasyToNavigate

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	5
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	6
4	7	4	7
4	6	5	1
4	5	5	8
4	3	5	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: BoldDesign

Moments			
N	9	**Sum Weights**	9
Mean	2.33333333	**Sum Observations**	21
Std Deviation	1.22474487	**Variance**	1.5
Skewness	0.23328474	**Kurtosis**	-1.5555556
Uncorrected SS	61	**Corrected SS**	12
Coeff Variation	52.4890659	**Std Error Mean**	0.40824829

Basic Statistical Measures			
Location		**Variability**	
Mean	2.333333	**Std Deviation**	1.22474
Median	2.000000	**Variance**	1.50000
Mode	1.000000	**Range**	3.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-1.63299	**Pr > |t|**	0.1411
Sign	**M**	-1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	-9	**Pr >= |S|**	0.1719

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.869558	**Pr < W**	0.1216
Kolmogorov-Smirnov	**D**	0.195182	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.064674	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.463188	**Pr > A-Sq**	0.2009

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: BoldDesign

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	3
50% Median	2
25% Q1	1
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	2	7
1	8	3	2
1	3	3	4
2	7	4	5
2	1	4	6

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Dynamic

Moments			
N	9	**Sum Weights**	9
Mean	2.77777778	**Sum Observations**	25
Std Deviation	1.30170828	**Variance**	1.69444444
Skewness	-0.3544253	**Kurtosis**	-1.8064268
Uncorrected SS	83	**Corrected SS**	13.5555556
Coeff Variation	46.8614981	**Std Error Mean**	0.43390276

Basic Statistical Measures			
Location		**Variability**	
Mean	2.777778	**Std Deviation**	1.30171
Median	3.000000	**Variance**	1.69444
Mode	4.000000	**Range**	3.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	-0.51215	**Pr > |t|**	0.6224
Sign	**M**	0	**Pr >= |M|**	1.0000
Signed Rank	**S**	-4	**Pr >= |S|**	0.5547

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.815772	**Pr < W**	0.0309
Kolmogorov-Smirnov	**D**	0.270563	**Pr > D**	0.0562
Cramer-von Mises	**W-Sq**	0.10532	**Pr > W-Sq**	0.0837
Anderson-Darling	**A-Sq**	0.692291	**Pr > A-Sq**	0.0464

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Dynamic

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	3
25% Q1	2
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	3	4
1	5	4	2
2	7	4	3
2	1	4	6
3	4	4	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Attractive

Moments			
N	9	**Sum Weights**	9
Mean	3.66666667	**Sum Observations**	33
Std Deviation	0.5	**Variance**	0.25
Skewness	-0.8571429	**Kurtosis**	-1.7142857
Uncorrected SS	123	**Corrected SS**	2
Coeff Variation	13.6363636	**Std Error Mean**	0.16666667

Basic Statistical Measures			
Location		**Variability**	
Mean	3.666667	**Std Deviation**	0.50000
Median	4.000000	**Variance**	0.25000
Mode	4.000000	**Range**	1.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	4	**Pr > |t|**	0.0039
Sign	**M**	3	**Pr >= |M|**	0.0313
Signed Rank	**S**	10.5	**Pr >= |S|**	0.0313

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.617278	**Pr < W**	0.0002
Kolmogorov-Smirnov	**D**	0.414174	**Pr > D**	<0.0100
Cramer-von Mises	**W-Sq**	0.306292	**Pr > W-Sq**	<0.0050
Anderson-Darling	**A-Sq**	1.706373	**Pr > A-Sq**	<0.0050

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Attractive

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	7	4	3
3	4	4	5
3	1	4	6
4	9	4	8
4	8	4	9

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
*Variable: AppropriateAgeGroup_13_17_*

Moments			
N	9	**Sum Weights**	9
Mean	3.44444444	**Sum Observations**	31
Std Deviation	1.33333333	**Variance**	1.77777778
Skewness	-0.6612723	**Kurtosis**	-0.1531808
Uncorrected SS	121	**Corrected SS**	14.2222222
Coeff Variation	38.7096774	**Std Error Mean**	0.44444444

Basic Statistical Measures			
Location		**Variability**	
Mean	3.444444	**Std Deviation**	1.33333
Median	4.000000	**Variance**	1.77778
Mode	4.000000	**Range**	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1	**Pr > |t|**	0.3466
Sign	**M**	1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	5.5	**Pr >= |S|**	0.4688

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.921805	**Pr < W**	0.4074
Kolmogorov-Smirnov	**D**	0.217094	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.057995	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.346641	**Pr > A-Sq**	>0.2500

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: AppropriateAgeGroup_13_17_

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	9	4	1
2	2	4	6
3	5	4	7
3	4	5	3
4	7	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Appealing

Moments			
N	9	Sum Weights	9
Mean	4	Sum Observations	36
Std Deviation	0.70710678	Variance	0.5
Skewness	0	Kurtosis	-0.2857143
Uncorrected SS	148	Corrected SS	4
Coeff Variation	17.6776695	Std Error Mean	0.23570226

Basic Statistical Measures			
Location		Variability	
Mean	4.000000	Std Deviation	0.70711
Median	4.000000	Variance	0.50000
Mode	4.000000	Range	2.00000
		Interquartile Range	0

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	4.242641	Pr > |t|	0.0028
Sign	M	3.5	Pr >= |M|	0.0156
Signed Rank	S	14	Pr >= |S|	0.0156

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.833482	Pr < W	0.0489
Kolmogorov-Smirnov	D	0.277778	Pr > D	0.0441
Cramer-von Mises	W-Sq	0.149277	Pr > W-Sq	0.0202
Anderson-Darling	A-Sq	0.774202	Pr > A-Sq	0.0276

Quantiles (Definition 5)	
Level	Quantile
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Appealing

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	4
10%	3
5%	3
1%	3
0% Min	3

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
3	4	4	6
3	2	4	7
4	9	4	9
4	7	5	3
4	6	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Professional

Moments			
N	9	Sum Weights	9
Mean	3.33333333	Sum Observations	30
Std Deviation	0.8660254	Variance	0.75
Skewness	-0.8247861	Kurtosis	-1.0793651
Uncorrected SS	106	Corrected SS	6
Coeff Variation	25.9807621	Std Error Mean	0.28867513

Basic Statistical Measures			
Location		Variability	
Mean	3.333333	Std Deviation	0.86603
Median	4.000000	Variance	0.75000
Mode	4.000000	Range	2.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	Statistic		p Value	
Student's t	t	1.154701	Pr > |t|	0.2815
Sign	M	1.5	Pr >= |M|	0.4531
Signed Rank	S	6	Pr >= |S|	0.4531

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.748483	Pr < W	0.0052
Kolmogorov-Smirnov	D	0.334846	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.166769	Pr > W-Sq	0.0110
Anderson-Darling	A-Sq	1.010532	Pr > A-Sq	0.0065

Quantiles (Definition 5)	
Level	Quantile
100% Max	4
99%	4
95%	4

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_Professional

Quantiles (Definition 5)	
Level	**Quantile**
90%	4
75% Q3	4
50% Median	4
25% Q1	3
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	9	4	2
2	1	4	3
3	5	4	6
3	4	4	7
4	8	4	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_UpToDate_2016DesignTechni

Moments			
N	9	**Sum Weights**	9
Mean	3.44444444	**Sum Observations**	31
Std Deviation	1.01379376	**Variance**	1.02777778
Skewness	-0.2704014	**Kurtosis**	-0.7626004
Uncorrected SS	115	**Corrected SS**	8.22222222
Coeff Variation	29.4327219	**Std Error Mean**	0.33793125

Basic Statistical Measures			
Location		**Variability**	
Mean	3.444444	**Std Deviation**	1.01379
Median	4.000000	**Variance**	1.02778
Mode	4.000000	**Range**	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.315192	**Pr > |t|**	0.2249
Sign	**M**	1.5	**Pr >= |M|**	0.4531
Signed Rank	**S**	7	**Pr >= |S|**	0.3594

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.891776	**Pr < W**	0.2081
Kolmogorov-Smirnov	**D**	0.263708	**Pr > D**	0.0709
Cramer-von Mises	**W-Sq**	0.092593	**Pr > W-Sq**	0.1241
Anderson-Darling	**A-Sq**	0.524883	**Pr > A-Sq**	0.1341

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: Layout_UpToDate_2016DesignTechni

Quantiles (Definition 5)	
Level	**Quantile**
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	2
5%	2
1%	2
0% Min	2

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
2	9	4	2
2	5	4	3
3	4	4	6
3	1	4	7
4	7	5	8

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: DesignedWithCare

Moments			
N	9	**Sum Weights**	9
Mean	3.55555556	**Sum Observations**	32
Std Deviation	1.23603308	**Variance**	1.52777778
Skewness	-0.9288198	**Kurtosis**	1.36859504
Uncorrected SS	126	**Corrected SS**	12.2222222
Coeff Variation	34.7634304	**Std Error Mean**	0.41201103

Basic Statistical Measures			
Location		**Variability**	
Mean	3.555556	**Std Deviation**	1.23603
Median	4.000000	**Variance**	1.52778
Mode	3.000000	**Range**	4.00000
		Interquartile Range	1.00000

Note: The mode displayed is the smallest of 2 modes with a count of 3.

Tests for Location: Mu0=3				
Test	**Statistic**		**p Value**	
Student's t	**t**	1.3484	**Pr > |t|**	0.2145
Sign	**M**	2	**Pr >= |M|**	0.2188
Signed Rank	**S**	5.5	**Pr >= |S|**	0.3125

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.889112	**Pr < W**	0.1954
Kolmogorov-Smirnov	**D**	0.215436	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.076045	**Pr > W-Sq**	0.2131
Anderson-Darling	**A-Sq**	0.471585	**Pr > A-Sq**	0.1907

Usability Data Analysis - (COLORS App Dataset) - March 1, 2017

The UNIVARIATE Procedure
Variable: DesignedWithCare

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5
99%	5
95%	5
90%	5
75% Q3	4
50% Median	4
25% Q1	3
10%	1
5%	1
1%	1
0% Min	1

Extreme Observations			
Lowest		**Highest**	
Value	**Obs**	**Value**	**Obs**
1	5	4	2
3	9	4	3
3	4	4	6
3	1	5	7
4	6	5	8

APPENDIX N (3 pages)

ChemiNet Raw Data

Simple&Natu	Consistency	AffordancesM	SpeakUsersLa	Wonderful	Easy	Stimulating	Satisfying	Flexible	ClearDesign	AestheticDes	PleasantDesi	CleanDesign
4	4	4	4	3	3	3	3	3	4	4	4	4
2	2	2	3	2	5	1	3	1	1	1	1	1
3	3	4	4	3	5	3	4	2	4	2	3	2
3	4	3	4	3	5	4	3	3	4	2	4	4
5	5	5	5	4	4	4	4	4	4	2	2	2
4	3	4	3	3	4	2	3	3	4	3	3	3
4	2	2	4	3	4	3	3	3	3	2	2	3
5	5	5	5	2	5	2	3	3	4	2	2	5
3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	4	3	5	2	1	3	3	3	3	3
2	2	1	4	2	3	1	2	3	1	1	1	2
4	4	4	4	2	2	2	2	2	3	2	3	2
3.417	3.333	3.333	3.917	2.75	4	2.5	2.833	2.75	3.167	2.25	2.583	2.833

COLORS Raw Data

Simple&Natu	Consistency	AffordancesM	SpeakUsersLa	Wonderful	Easy	Stimulating	Satisfying	Flexible	ClearDesign	AestheticDes	PleasantDesi	CleanDesign
3	4	4	4	3	3	2	2	3	4	2	2	4
4	4	4	4	4	3	4	4	4	4	4	4	4
5	5	4	4	5	5	5	5	5	5	5	5	5
3	3	3	3	5	3	3	3	3	3	3	3	3
4	1	3	3	1	1	1	3	1	4	4	4	4
4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	4	5	4	5	5	5	5	5	5	4	5
4	5	4	5	4	3	2	4	2	5	3	5	5
5	5	5	5	2	5	2	1	2	4	1	4	4
4.111	4	3.889	4.111	3.556	3.556	3.111	3.444	3.222	4.222	3.444	3.889	4.222
0.694	0.667	0.556	0.194	0.806	-0.444	0.611	0.611	0.472	1.056	1.194	1.306	1.389

SymmetricDe	CreativeDesi	Sophisticate	OriginalDesig	UseSpecialEf	FascinatingD	Use2016Desi	UsingHeroIm	UseLongScro	LayoutEasyT	SiteGoesToge	Layout_Well	Layout_Pleas
4	4	3	4	5	2	4	1	1	5	3	4	4
1	1	1	1	1	1	1	1	1	5	3	1	1
4	2	2	3	3	2	3	5	2	5	3	4	4
3	3	4	4	2	3	4	4	3	4	4	4	4
3	4	2	4	4	2	2	3	3	4	2	4	4
3	2	2	3	2	2	2	3	3	4	3	3	3
3	3	3	3	3	3	3	2	2	4	2	4	4
5	3	2	3	4	2	3	1	1	5	5	5	3
3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3
4	2	2	5	2	1	3	3	4	1	4	4	2
4	3	1	4	2	2	1	4	3	4	4	4	4
3.333	2.75	2.333	3.333	2.833	2.167	2.667	2.75	2.417	3.917	3.25	3.583	3.25

SymmetricDe	CreativeDesi	Sophisticate	OriginalDesig	UseSpecialEf	FascinatingD	Use2016Desi	UsingHeroIm	UseLongScro	LayoutEasyT	SiteGoesToge	Layout_Well	Layout_Pleas
3	3	2	2	3	4	3	1	2	4	3	3	3
4	4	4	4	5	4	4	3	3	4	4	4	4
4	4	5	4	4	4	4	5	3	2	5	4	4
3	3	3	3	3	3	3	3	3	3	3	3	3
4	2	2	1	1	1	1	1	1	4	4	4	1
4	4	4	4	4	4	4	4	4	4	4	4	4
4	4	4	4	5	4	4	3	3	5	3	4	4
5	3	2	5	3	3	3	3	4	4	2	5	4
4	2	2	4	1	1	4	3	3	5	5	4	4
3.889	3.222	3.111	3.444	3.222	3.111	3.333	2.889	2.889	3.889	3.667	3.889	3.444
0.556	0.472	0.778	0.111	0.389	0.944	0.667	0.139	0.472	-0.028	0.417	0.306	0.194

Layout_Inver	Layout_Easy1	BoldDesign	Layout_Dyna	Attractive	Appropriate/	Appealing	Layout_Profe	Layout_UpTc	DesignedWithCare
4	4	2	2	4	4	4	5	5	5
1	5	5	1	1	4	1	1	1	1
2	5	3	2	3	4	4	2	3	3
4	4	3	3	3	5	3	4	4	4
4	4	5	5	4	4	4	2	2	2
2	4	3	3	2	5	3	3	3	4
4	4	3	3	2	2	2	3	3	3
3	5	5	3	1	2	2	5	2	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
2	3	4	2	1	1	1	3	3	2
2	1	2	3	3	1	4	1	1	1
2.833	3.75	3.417	2.75	2.5	3.167	2.833	2.917	2.75	2.833

Layout_Inver	Layout_Easy1	BoldDesign	Layout_Dyna	Attractive	Appropriate/	Appealing	Layout_Profe	Layout_UpTc	DesignedWithCare
3	5	2	2	3	4	4	2	3	3
4	4	3	4	4	2	3	4	4	4
4	4	1	4	4	5	5	4	4	4
3	3	3	3	3	3	3	3	3	3
1	4	4	1	4	3	4	3	2	1
4	4	4	4	4	4	4	4	4	4
4	4	2	2	3	4	4	4	4	5
4	5	1	4	4	5	5	4	5	5
2	5	1	1	4	1	4	2	2	3
3.222	4.222	2.333	2.778	3.667	3.444	4	3.333	3.444	3.556
0.389	0.472	-1.083	0.028	1.167	0.278	1.167	0.417	0.694	0.722