MarQuiz:
A Web-Based Examination System Solution

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Abstract – *Assessment is one of the critical constituents of classroom instruction. Using the traditional procedure of examination often results in human errors during the grading process and can be time consuming. Nowadays, with the technology advancement and the evolution of users' needs, web-based examination system is made to deal with these challenges for an academic solution to conduct fast examinations and accurate results.*
In this study, we developed an effective web application, named "MarQuiz" composed of three primary roles, including teachers, students and administrators by using a combination of programing language tools such as HTML, CSS, PHP, MYSQL, and JavaScript.
This system aims to reduce proportion of workload on examination, grading and reviewing on the part of instructors and students. Hence, it enables the release of examination results in record time and without error.

Keywords – *Web-based examination system, Randomized Quiz Questions, Multiple choice, Auto-grading system, Agile XP*

1. Introduction

Today, with the popularization of the computer and the continuous development of the multimedia and network, education is evolving from a traditional to a digital and web-based perspective. Hence, to save time and to avoid printing and working on the papers, grading students' copies; online examination using computers becomes a preferred and easy way for instructors to create assignments and for students to take their examinations in a favorable way on their own time, with their own PCs regardless of their location. Therefore, it is convenient to develop a web-based examination system that both instructors and students can benefit from.

Many researchers have focused on publishing different web-based examination systems based on the following:

- ***Google Classroom*** is a free platform was published in 2014. Google classroom tool is easy to use and flexible, saves time, cloud-based, communication and mobile friendly. [1]
- ***ProProf*** is a cloud-based software founded by Sammer Bhatiafor to create quizzes, training, and flashcards. ProProf features can make tests with an exciting template, and auto-grading system. Fees may apply to have full functionally of this software. [2]
- ***ClassMaker*** is a web-based software to create tests and quizzes for education or business use. It allows users to create random questions tests, instant feedback, immediate results. Fees may also apply to have full functionally of this software. [3]

There are many web-based examination systems available online, but most of them are not free and their features are not all accessible without paying fees.
Therefore, in this study we aim to build a modern and accessible software allowing teachers and students use and get excellent experience with this system.

This paper is structured as follows:
In section 2, we will present the motivation. Section 3 will be focused on system characteristics. In section 4, we will describe some related works. In section 5, we will introduce an overview about our solution. In section 6, we will demonstrate the implementation details of MarQuiz. In section 7, we will evaluate our developed system. Next, in section 8 we will discuss MarQuiz features including strength and weakness. Then, in section 9 we will explore the impact of MarQuiz. Finally, discussions and thoughts based on the proposed solution will be presented.

2. Motivation

The motivation for this project was to create an online assessment tool for the 21st century classroom that would not only make assessment more efficient for teachers but would also provide faster feedback to the students as well. Many school districts have made the transition to the standards-based grading system which adds an increased amount of work for teachers during assessment. Teachers are now required to allow retakes on assessments and in some districts the number of retakes allowed per student is endless. This means that teachers must grade multiple assessments for each student on just one topic and that they must also create multiple assessments to prevent cheating. Additionally, teachers must create custom assessments for students with special needs based on legal criteria detailed in the student's Individualized Education Plan. Often these plans will include increased time, less options on multiple choice questions, and shorter assessments. While most classrooms only have a few students with IEPs, in some cases a majority of the student in the class have an IEP which requires the creating of many different assessments. Standards-based grading also calls for teachers to grade each student on every standard related to the course based on guidelines from the Department of Public Instruction. In some cases, there are over 60 standards for just one course.

To highlight the need for this tool, imagine a scenario where a teacher has a standard class of 25 students and 40 standards to assess. Assuming that the teacher has five classes with these requirements, that amounts to 5000 assessments that must not only be graded, but also must provide useful feedback to the students. With the addition of retakes, that number is increased two-fold or greater in most cases. The recent teacher shortages and increased burn out ratings made it essential to find solutions to the overwhelming demands put on teachers. We sought to make this process as efficient as possible for all parties involved to meet the increased demands of assessment and reduce stress endured by teachers to provide timely feedback.

3. Characteristics of the system

MarQuiz was designed with efficiency and versatility in mind. Once student and teacher accounts are created, a teacher may begin creating classes and providing the autogenerated class code to students to join their class. Class tiles with a subject related image will be added to both the student and teacher homepages for easy access. Teachers and students may later remove the student from the course with a simple click of a button on the class homepage.

The creation of quizzes offers teachers many specialized options including the number of questions, the time limit, and the number of retakes a student can have. MarQuiz will automatically generate a quiz from a bank of questions provided by the teacher in a randomized order. This feature ensures that each quiz attempt will be unique, and the integrity of the assessment is upheld. For example, a teacher may want to give a 10-question assessment but can create 20 questions from which the assessment can be randomly autogenerated from. A time limit can be set for the quiz and it will be automatically submitted if not submitted before the deadline. Teachers can also create quizzes with longer time limits to meet specialized testing requirements detailed in student IEPs. Lastly, teachers can set a predefined number of retakes as needed. More retakes can be assigned for students with IEPs if necessary or zero can be chosen for courses or assessments, like final exams, where retakes are not permitted.

Once a quiz has been created, the teacher must activate the quiz before it will appear on the students' homepage. This ensures that the student does not have access to the quiz until the teacher is ready for assessment. The teacher can then deactivate and reactivate the quiz as necessary. For example, a teacher can deactivate a quiz after the class period is over to prevent students from taking a quiz in an unknown environment and then reactivate the quiz when the students return the next day. The MarQuiz website can also be used with student tracking tools such as GoGuardian to prevent the student from using other tabs. MarQuiz itself will prevent the student from refreshing or using the back button during a quiz. All of these features were added to ensure that testing is done with fidelity.

At the conclusion of a quiz attempt, MarQuiz will automatically score and store the results before providing immediate feedback to the student. Scores are stored and updated in two categories, first attempt and best attempt, to provide additional statistics to the teacher for tracking growth. Students are given the number of questions correct out of the total number of questions, their percentage, and information on incorrect answers if necessary. MarQuiz will provide students with each question that was incorrect, their chosen answer, and the correct answer. After reviewing their scores, students can retake their quiz if allowed. MarQuiz will autogenerate a new quiz from the question bank randomly and the process will repeat. The teacher need not intervene at any point during the testing and retesting process unless they wish to deactivate the quiz for retaking at a later date. Teachers

and students can then access quiz results on the class homepage.

One of the most useful tools on MarQuiz is the copy a quiz tool. Teachers can use this tool to copy the quiz to another class an edit the quiz as necessary. This is especially useful for creating custom quizzes for students with IEPS or enhancing a quiz for an honors class. Generally, teachers have multiple sections of the same course so the main functionality would be allowing multiple classes to access the same quiz. These customizing options were designed to make assessment creation simple and efficient for teachers and getting assessment feedback immediate for students.

4. Related works

One of the most utilized assessment options, especially before the increased accessibility of computers, was a paper and pencil assessment. While this approach allowed for a wider variety of question types (matching, short answer, creation, etc.), each assessment must be graded by hand, usually by the teacher. One of the main advantages of this option is that it does not require any use of technology. It is also very efficient for teachers to create a quiz at any moment when necessary by writing questions on the board and having students answer them on paper. However, this approach usually requires teachers to bring large stacks of assessments home to be graded outside of work hours putting more stress on the teacher and longer wait time on results for students.

There are several online assessment tools on the market. Google forms is a popular tool because of its integration with google classroom, which has been widely adopted by school districts. Teachers can create a variety of question types such as multiple choice, checkboxes, short answer, and paragraphs. Videos and images may also be added to test questions. Each question has the option for the number of points assigned. The assessments can be automatically graded, but in the case of short answer and written paragraphs teacher review is still necessary to assign final grades. Teachers can choose when they want to provide results and add additional written feedback if necessary. Google forms provides statistics on assessments such as averages, information on frequently missed questions, and graphs marked with correct answers. Teachers also have the option to lock students into the quiz to prevent them from opening other tabs or applications. Google forms does not allow teachers to delay retakes or generate random questions from a bank. To increase testing integrity, teachers can only shuffle questions or create a new test. While google forms does offer a wider variety of test creation features and feedback, it lacks in testing integrity for retaking assessments. [1]

Proprofs online assessment tool for a broader range of professions that offers three levels of membership with increased features at each level. While the base level will allow users to create unlimited quizzes and utilize the automatic grading feature, all quizzes must be public which compromises the integrity of the assessment. For additional feature the teacher must pay $0.25 per test taker monthly. At this level the teacher can make quizzes private, use statistic tools for results, and add up to 5 groups of test takers. The teacher can create questions that are multiple choice, matching, checkbox, short answer, and fill in the blank. Images and videos can be added but points cannot be assigned. Retakes are not optional unless a new quiz is created and assigned. Question banks and randomization are also not optional. While there are a wide variety of analysis tools, Proprofs lacks the capability of cheaper competitors with more options desired by teachers. [2]

Another useful online assessment tool is ClassMaker. Teachers can create a variety of question types such as multiple choice, matching, short answer, and paragraphs. Like Google forms, points can be assigned to each question and the assessments can be automatically graded unless short answer and essay questions are involved. Teachers can choose to have questions randomly pulled from the question bank or design a quiz for each student to take that is identical. They also have an added usability of selecting fixed questions and the amount of autogenerated questions in case there are certain questions they want to have on every quiz. Questions can also be assigned to a category allowing the teacher to choose how many questions of a certain category should be randomly generated for a quiz. Teachers can create time limits, select availability dates, and decide when they want students to get their results. After testing is completed, teachers can view question analysis statistics and class averages. ClassMaker does allow retakes, but each attempt is the same as the previous which lowers the integrity of the test. ClassMaker is also free initially, but you must pay a monthly fee after the trial expires. [3]

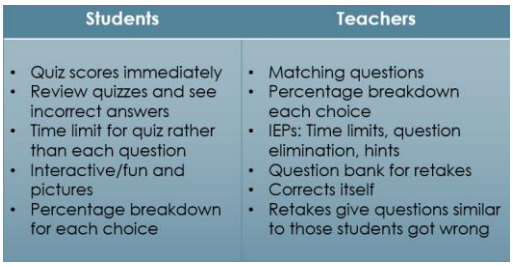
Assessment Tool	Specialized Features	Deficiencies
MarQuiz	• Autogenerated randomized quizzes and retakes • Self-grading • Immediate results • Question	• Only allows multiple choice questions • Each question is weighted equally

	banks	
Paper Test	• Best question type variety • Can assign points to each question • Technology access in not necessary	• Must be graded by hand • Long wait for results • Retakes are not autogenerated
Google Forms	• Wide variety of question types • Can assign point to each question • Videos and images for questions • Self-grading • Choose when feedback is released	• Self-grading is not available for all quizzes • Retakes cannot be delayed • No question banks
ProProf	• Wide variety of question types • Videos and images for questions • Best options for analytical tools of quiz results • Self-grading	• Monthly fee • Each question is weighted equally • Retakes are not autogenerated • No question banks • Only 5 classes can be created
Class Maker	• Best options for autogenerating quizzes • Optional randomization • Wide variety of question types • Can assign points to each question • Self-grading • Choose when feedback is released • Question banks	• Self-grading is not available for all quizzes • Monthly fee after initial trial expires • Retakes are the same as the initial quiz

5. Overview of the proposed solution

MarQuiz is a new tool designed to be user-friendly and intuitive to manage online assessments in order to simplify the way of creating, delivering and grading quizzes in a paperless and efficient way. *MarQuiz* makes it easy for users to connect whatever their location, in/off-campus or schools.

Our target audiences are particularly the schools and colleges teachers and students. During the development and the building of our system, we worked under *Agile Extreme Programing (XP)* environment where our highest priority is to meet the expectation of the stakeholders of our system. For this reason, before starting the implementation, we focused to collect users' stories via a questionnaire that we provided to the teachers and the students of a public school, in order to understand what they need exactly and what they wish to see it in our system as illustrated below:



From the teachers' perspective, building a secure system that helps them easily create quizzes, lets them manage the way of creating and delivering the examination based on their criteria, takes into consideration students with special needs, and allows them to save their time and stay organized; would be very beneficial for them.

On the other hand, from the students' point of view taking a quiz from an interactive system content that enables them to know immediately how well they did on their examinations and lets them learn from their mistakes for future attempts; would be very helpful for them as well.

6. Details of the solution

MarQuiz allows users to sign up for accounts and indicate whether they are a student or teacher. Each account has a username, password, role, and email address. The email address is currently only used to allow the user to reset their password in the case that they've forgotten it. Once an account has been created, a user can update their account details and password.

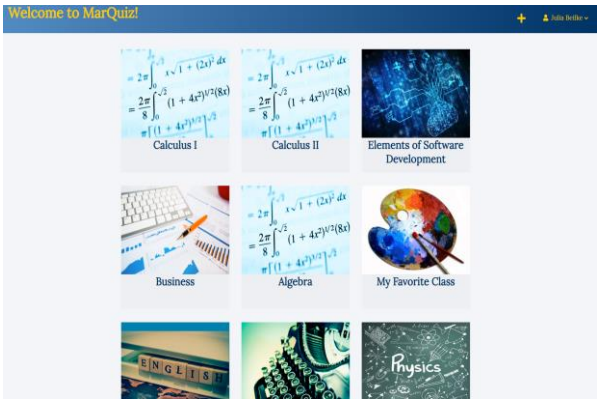
Based on the role that the user selected when creating an account, the user will see either a teacher or student homepage when they log in. They will have access to a certain set of pages and functions.

6.1. Teacher perspective

When teachers log in for the first time, they see a welcome message that instructs them on how to add their first class. There is a button in the top navigation bar on the homepage that allows teachers to create new classes by entering a class name and choosing from a list of subjects. When a class is created, a random and unique code is generated. Teachers will share this code with students so that they may join the class.

We store a table in our database that includes subjects and a file name which points to an image file within our file system. When the teacher's classes populate on their dashboard, they see a tile for each class that includes the class name and the image related to the class subject.

Teacher homepage This is an example of a teacher's homepage.



Each class tile links to a dashboard for the class. From the class dashboards, teachers can:

- View information such as the unique class code, the number of students enrolled, and the number of quizzes they've created for the class.
- View and edit existing quizzes.
- Copy existing quizzes to another class. This will also copy the questions for that quiz into the new class.
- Create new quizzes. When quizzes are created, the teacher designated the number of questions that should be generated when a student takes the quiz, the time limit, and the number of attempts students will be allowed to make.
- Activate, close, or reactivate quizzes. When a quiz is first created, it is inactive and hidden from students. Students will not see it in the list of quizzes to take or in the list of their grades for the class. When a quiz is active, students can take the quiz and view scores for the quiz. Once a quiz has been closed, students can view their scores, but can no longer take the quiz, even if they have remaining attempts.
- Add questions to quizzes.
- View, edit, and delete existing questions.
- See their students' grades for each quiz.
- Remove students from their class.

Teacher class dashboard This is what the teacher will see when they click on a class tile from their homepage.

6.2. Student perspective

The student homepage looks very similar to the teacher homepage. When students log in for the first time, they see a welcome message that instructs them to their first class. There is a button in the top navigation bar on the homepage that allows students to join classes by entering a unique class code which they have received from their teacher.

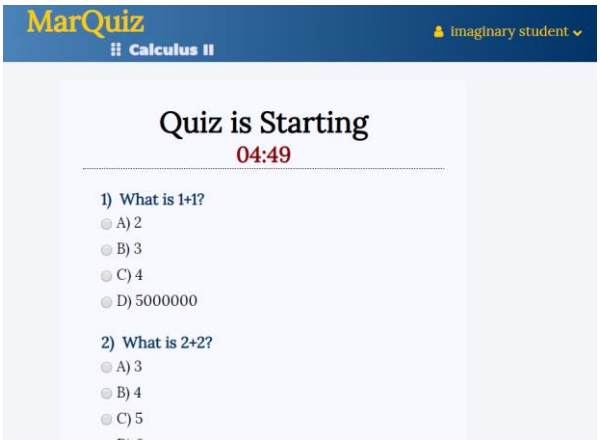
Once a student has joined a class, they will a tile for that class on their homepage. These tiles look exactly like the tiles on the teacher dashboard. If the class has active quizzes that the student has not attempted, there will be a 'New Quiz' notification on the tile.

Tiles on the student homepage link to the student version of a class dashboard. From their class dashboards, students can:

- View the list of quizzes that they can take. Students can take a quiz if the quiz is active and the student has not exhausted their attempts.
- Take quizzes from this list.
- View their grades. If there is an open or closed quiz that the student has not yet attempted, the grade will show as "n/a."

When a student takes a quiz, a countdown timer will display at the top. The countdown time is based on the time limit set by the teacher. If the timer runs out before the student submits the quiz, the quiz will be scored as is. Similarly, if the student clicks the browser back button when taking the quiz, they will be warned that the quiz will be scored as is if they proceed. The student will have the option to dismiss the warning and resume the quiz.

Quiz Here is what a quiz looks like from the student perspective.



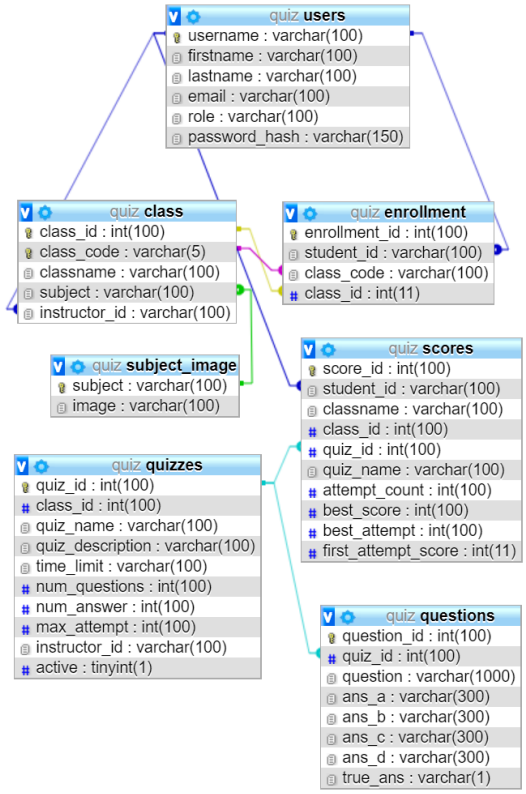
Once the quiz is submitted, the system will score the quiz, and the student will be redirected to a page that shows the following information:

- The total questions on the quiz.
- The total questions that the student answered correctly.
- The percentage of questions that were answered correctly.
- The best score they have earned on this quiz, if multiple attempts have been made.
- For questions that were answered incorrectly, the question, the answer that they selected, and the correct answer.

6.3. Technical implementation details

We have developed MarQuiz as a web application using php, MySQL, javascript, html, and CSS. MarQuiz's user, class, and quiz data is stored in tables in a MySQL database. The database, as well as the html, php, javascript, CSS, and image files for the webpages are hosted on Linux server on Marquette's MSCSNET domain. MSCSNET is maintained by Marquette's computer science department.

Structural Diagram Below is the structure for our database tables.



6.3.1. Password security. Upon account creation, MarQuiz implements the built-in php password_hash() function to generate a hash of the password that the user has entered. The hash is stored in the table rather than storing the password as plain text. When a login attempt is made, we use the password_verify() function to verify the text that the user has entered against the password hash that is stored in the database. If a malicious actor were to access our database, this would prevent them from viewing our user's passwords.

Users are required to enter passwords that are at least 6 characters, include uppercase and lowercase letters, and at least one number. This is enforced when a user creates an account or updates their password.

6.3.2. PHP sessions. When a user logs in, a php session is started and the username is stored as a session variable. We use session variables to store information about the user and their classes so that the information can be accessed for all pages throughout the website. Server-side php and MySQL code is executed when pages load, and the appropriate information will display based on the session variables. For example, when the dashboard pages load, we select

the user's first and last name based on their username. The name is then displayed in the navigation bar at the top. Session variables and server-side code are essential for generating random quiz instances and scoring quizzes.

Session variables are also used to ensure the integrity of a session. This is done in two scenarios:

- If no username is stored for the session when a user visits a page, the user will be redirected to the login page. This will prevent a user who does not have an account from accessing any page other than the login page without signing in first.
- When a page is loaded, we store the current time as the last active time in a session variable. If half an hour has passed since the last active time for the session, the session is destroyed, and the user must log in again.

7. Evaluation of the solution

The MarQuiz web-based examination system is designed to be used in a classroom or other educational environment and can be implemented in any teacher-student dynamic. Though primarily intended for multiple choice examinations, MarQuiz can additionally be implemented for survey and polling purposes. Additional improvements must be incorporated before the final product is ready for mass use. System limitations and weakness will be discussed later in the appropriate section.

Beta testing has been conducted in the form of one on one trials with students of the Milwaukee Public Education System. Courtesy of developer Kristi Smet, sample quizzes, class enrollment and account creation experienced by select students have exceeded expectations. Recordings of the user experience have demonstrated ease of navigation and comprehension with all pages, links and notifications prompted by MarQuiz. Additional student testing has been conducted with pending results. While individualized feedback is constructive and useful for developmental improvement, mass feedback and large sample size testing will expose more systemic and organizational faults within our software.

An illustrative example of this individualized beta testing came from an adolescent female student who was asked to sample an introductory computer science quiz. Positive feedback from the student included ease of use of the website, clear and concise instructions on behalf of the site as well as a generally simple design that reduces clutter and does not draw attention away from the task at hand. Constructive criticism cited some of the lacking design elements, particularly a blank homepage seen after account creation which prompted confusion. Additionally, the student mentioned some of the unorthodox user interface components, derived from the simplicity of the site design and experience of the web developers. Despite this, the student concluded MarQuiz to be a generally improved examination system over competitor systems, including Google Classroom.

8. Strengths and weaknesses of our solution

Based on the user's stories that we collected, we tried to develop a web-based system that covers all the requirements and the expectations of our stakeholders. MarQuiz offers many features that can be benefit for both teachers and students, as stated below:

- ***User-friendly and intuitive:*** Teachers can easily create a class and share a generated class code with their students to join.
- ***Free:*** No more worries about paying fees to have all the functionalities of a software. MarQuiz allows all its users to access and use our features for free.
- ***Accessible:*** Teachers and students can easily connect to MarQuiz whatever their location inside or outside the schools, and they can also use any computer.
- ***Saves time and paper:*** No more writing to create quizzes, spending time and paper resources printing them. MarQuiz enable teachers to quickly create and distribute examination online.
- ***Secure system:*** Security is very important in our system against cyber hackers. MarQuiz requires their users to create a strong password that meets its criteria and then all the passwords will be hashed and stored in the database.
- ***Easy to manage quizzes and questions:*** Teachers will find that managing quizzes is elegantly simplistic with our specialized features such as creating with time limit, editing quizzes, and also copying a quiz from a class to another which also can save their time. They can even have the option to activate the quiz and publish it to their students or inactivate it and keep as draft. Moreover, teachers can easily add, edit and delete questions on any created quiz.
- ***Easy to manage account:*** Both teachers and students are able to edit their profile such as their name or passwords. They can even

delete their account if they stop using our system.

- ***Controls students list:*** Teachers can simply control their class list students by checking the number of enrolled students, their names and they can even delete unwanted students.
- ***Unenroll from a class:*** Students are also able to unenroll from any class that they will no longer be using it.
- ***Auto-grading system:*** Teachers will no longer manually grade the quizzes and spend their time to give their feedback to their students as they can choose the correct answers from the beginning when they create the quiz questions by letting our system automatically grading the quizzes.
- ***Quiz auto-submission:*** Students do not worry about how to submit the quiz when the quiz timer runs out as quizzes will automatically be submitted along with answered questions.
- ***Immediate scores and feedback***: Students will no longer need to wait for teacher feedback, as MarQuiz immediately and automatically scores and stores assessments. Students can also check their incorrect answers and see the correct answer before retaking.
- ***Randomized quiz questions:*** Teachers will not be worried about cheating as MarQuiz will automatically randomly generate a quiz from the bank of questions created by the teacher.
- ***Generates retakes:*** Creating specialized assessments for students with special needs can

be easily done by extending time, eliminating choice, and reducing the number of questions generated.

Despite the numerous advantages of this system, there are still some specific issues that we did not cover, but it will be fixed and upgraded depending on the users' demands and their satisfaction with the developed system. Below are the features that can be improved in the near future.

- ***The system doesn't support different quiz formats such as*** adding True/False questions in the assignment, filling in the blanks and open-ended.
- ***Enable to create engaging quizzes:*** Our system is not able to create engaging quizzes with video and audio, voice-overs, text-to-speech, etc.
- ***Lack of communication:*** No communication feature is provided into our system as not all teachers can send announcements or create class discussions with their students.
- ***No Android or IOS application availability:*** We still did not have the chance to develop a mobile application for our system compatible with Android and IOS mobile system to facilitate connection between teachers and students from their smartphones.
- ***Still under MSCS network:*** Users data are stored under the database of MSCS network of Marquette University. However, if there is a demand and need of this system, the deployment process will begin by submitting our website to Google for publications.

9. Impact

The MarQuiz examination system has the potential to impact online quiz and survey systems in a meaningful and useful manner. Most contemporary web-based examination systems cannot offer a closed environment without forcing users to install and use stand-alone browsers that offer web security. Other websites like Desire2Learn (D2L) have limitations in the sense that they must be fully incorporated with other class elements and cannot isolate multiple choice quizzes and surveys from other graded assessments. MarQuiz allows for this isolation and can store an individual's assessment data in the form of grades and responses as separate information from the rest of their graded material. MarQuiz includes design elements that similar web-based systems have not implemented, including unnavigable quiz pages that do not allow students to navigate away from active quizzes. This reduces incidences of academic integrity violation and inaccurate assessments of students' knowledge. This design elements impacts the field by adding much needed security to online assessments. From a broader perspective, the fruits of our research and development have the potential to improve online and in class web-based education by simplifying the process of designing and facilitating multiple choice assessments.

10. Discussion

Improvement of web-based multiple-choice examination begins with MarQuiz. To summarize the aforementioned, MarQuiz seeks to address the inadequate online assessment tools for educators and purveyors of survey material. Born from experience in the Milwaukee Public Education System, we, as developers, sought to improve the existing means of

administering examinations and create a “smart” classroom environment. After addressing user stories based on legitimate needs and requirements from future users, we developed a scaffold to build our website from, planning all home pages, functional elements and communicative relationships between objects. We established a secure connection with a database through the Mathematics and Computer Science department at Marquette University, which allowed us to create functional tables to store and change user information as needed. Through iterative steps and agile software development, we developed a finalized product with minimal limitation that is intended to be incorporated in legitimate educational contexts. The future for MarQuiz includes a database migration to a server independently owned and operated by MarQuiz. This will allow for complete administrative control over the site and will make table and design edits more convenient. As indicated by beta tested user feedback, design elements and user interface of the website will need improvement to make navigation more intuitive and linear for users. Finally, MarQuiz aspires to eventually broaden the scope of its functionality by adding short answer and essay type questions to quizzes and allow a means for individualized feedback for students on behalf of assessors.

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