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1 Privacy and ethics

Privacy and ethics are essential for secure web development as they protect user data, foster trust, mitigate risks, ensure legal compliance, and enhance the overall user experience. By prioritizing privacy and code of ethics, developers contribute to a safer and more responsible digital environment.

1.1 Data Protection

Privacy is essential to safeguard user data. Web developers must compliance with Privacy Laws and code of ethics to protect personal information collected through websites. Such as implementing encryption, secure data storage and access controls to prevent unauthorized access and data breaches.

1.2 User Trust

Respecting user privacy and code of ethics can build trust between users and websites. Users are more likely to share personal information and make transactions when they trust the website. Secure web development could encourage users to have stronger relationships with the website.

1.3 Ethical Data Handling

Developers have responsibility to handle user data ethically. They should state out the purpose and range of data collection, get users' agreement and only use data for its intended purpose. Ethical considerations also include ensuring transparency in data practices, providing users with control over their data, and minimizing the collection of personally identifiable information whenever possible.

1.4 Mitigating Risks

Privacy and ethics help in mitigating various risks associated with web development. By implementing secure functions, developers can mitigate cyber threats such as data breaches, identity theft and unauthorized access.

1.5 User Experience

Privacy and ethics can improve user experience. Respecting user privacy preferences and providing transparent data brings a better user experience and builds up a positive relationships between users and websites.

2 Mitigations

2.1 SQL Injection

SQL Injection is when SQL code is ran on a website via a textbox or entry field. The way we have mitigated this is by using parametrised queries wherever the user inputs data for a query. A parametrised query is a query that ”drops in” the variables instead of using string concatenation. Because the values are not added on the end and are instead dropped in, the user has no way of terminating the query to run their own code. We used the node library ”pg” to communicate with the database, this library had built in support for parametrised queries so no other library was needed. These queries function the same as normal queries and run at similar speeds to normal ones meaning the user wont notice the difference. As this is all happening server side it will have no direct impact on usability, however if these queries were to run slow then the user would notice.

2.2 Account Enumeration

Account Enumeration is when a user iterates through a dictionary of possible username and uses the response from the server to determine if that username is in use or not. The way we have prevented this is by making the response from the server the same whether the username or the password is incorrect making it hard to tell which one if any were correct. We have also made the timing of the responses the same so that they can not be told apart that way, this was done by running through the entire login process no matter whether the username or password was correct. This can have an impact on usability as it can make the process of forgetting login information slower and less informative, if you forget your credentials the website wont tell you which of them you got right which can be frustrating for users.

2.3 Cross-site Scripting

Cross-site Scripting is when code is injected into a website to then be executed later, this typically happens in the form of html and JavaScript code that gets issued to a text form to run when its displayed later. The way we have mitigated this is through html encoding, all of the html characters (<,>,”, &) needed to write code have special characters that represent them so websites can display them safely, we use this when displaying posts as its the only time code could be injected to run later. Before the posts are displayed on the screen they all go through a function that converts html characters to their display counterparts so < becomes &lt while being ran but will display as <. This should have little to no affect on usability as the users wont see the converted characters and the process is very fast so it should not be much slower than if we didn’t do it.

2.4 Cross-site Request Forgery

Cross-site request forgery (also known as CSRF) is a web security vulnerability that allows an attacker to induce users to perform actions that they do not intend to perform. It allows an attacker to partly circumvent the same origin policy, which is designed to prevent different websites from interfering with each other. The way we mitigate this is using CSRF token. A CSRF token is a unique, secret, and unpredictable value that is generated by the server-side application and shared with the client. When issuing a request to perform a sensitive action, such as creating a post, the client must include the correct CSRF token. Otherwise, the server will refuse to perform the requested action. CSRF tokens help protect against CSRF attacks by making it difficult for an attacker to construct a valid request on behalf of the victim. As the attacker has no way of predicting the correct value for the CSRF token, they won’t be able to include it in the malicious request.

2.5 Session Hijacking

Session hijacking is as the term suggests. A user in a session can be hijacked by an attacker and lose control of the session altogether, where their personal data can easily be stolen. After a user starts a session such as logging into a banking website, an attacker can hijack it. In order to hijack a session, the attacker needs to have substantial knowledge of the user's cookie session.

We used two methods to mitigate session hijacking. We used HTTPS to ensures that there is SSL/TLS encryption throughout the session traffic. Attackers will be unable to intercept the plaintext session ID, even if the victim's traffic was monitored. We also used session keys for our website. This renders the session ID extracted by attackers useless as the ID changes immediately after authentication.

3 Authentication methods

The main aim of authentication methods, are to increase the security of a website however this can come at a price, usually increasing the time it takes for users to login. Two-Factor Authentication along with a password are the two most common forms of authentication methods and can be seen on most modern websites. Two-Factor Authentication requires users to enter a "One-time password (OTP)" from another device, such as a mobile device, into the website they're attempting to verify themselves to.

3.1 Passwords

In order to increase security of the website, authentication methods were needed. The most common form of authentication is the use of a password being assigned to each username when users created their account. Despite passwords increasing security, a study by Google in 2019 concluded that "52% reuse the same password for multiple (but not all) accounts." [1] This study showed how poor the general public are at ensuring their accounts are safe and therefore multiple authentication methods are needed. Therefore, another authentication method would be needed to further increase security.

3.2 Two-Factor Authentication

The other authentication method that was created and coded was the use of "Two-Factor Authentication (2FA)". During account registration, users need to download an application onto their mobile device. The application known as "Google Authenticator" randomly generates a 6-digit code every 30 seconds which the user needs to enter correctly before their account is successfully created. When users are logging in, they will also be prompted to enter their code into the website. Despite this increasing the time taken to login, "80% of security breaches can be prevented with 2FA" [2] and so this small increase in time is beneficial in increasing security.

4 Testing

4.1 Think Aloud Testing

Think aloud testing is when users are handed the product, in this case the website, and asked to perform a series of tasks, they are monitored during this and their progress is recorded along with any issues they encounter. This type of testing is for usability and is typically performed in 3 or more rounds, you would record the results of people in different demographics and using the notes make improvements, after the improvements a new group of people from the same demographics would use the site.

The tasks the users where asked to perform where:

- Register an account
- Make a post
- Log out
- Log in
- View the post you made
- View all available posts

These tasks where performed in the order listed and allowed us to test all aspects of our site individually. We tested on 3 different demographics, young male university students, young female sixform students and female adults.

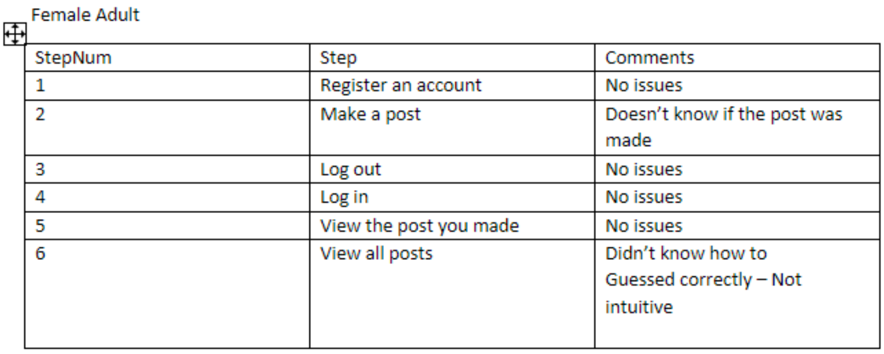
The young male managed to create an account with ease and make a post, however he noted that the website gives a lack of information on whether the post was successfully made or not causing this task to take longer than expected. He had no problems logging out and then back in, he tried to search for the category his post was under however our search bar only works based off of title so it didn't work. To view all posts he simple pressed buttons on the screen around the search bar and happened to press the search button while the bar was empty which shows every post. Overall he did not find it easy to use due the lack of feedback the site gives on whether actions are successful or not. The table of results for this test can be found in Figure 3.

The young female did not like the 2 factor authentication used as it required a new app on their phone. She had no issues until tasked with viewing all posts, after a couple of minutes of looking they gave up. The table of results for this can be found in Figure2.

The adult female had the same issues as the young male, they didn't know if the test was successfully made and they did not easily find the way to search for all posts. The table of results can be found in Figure1.

4.2 Unit Testing

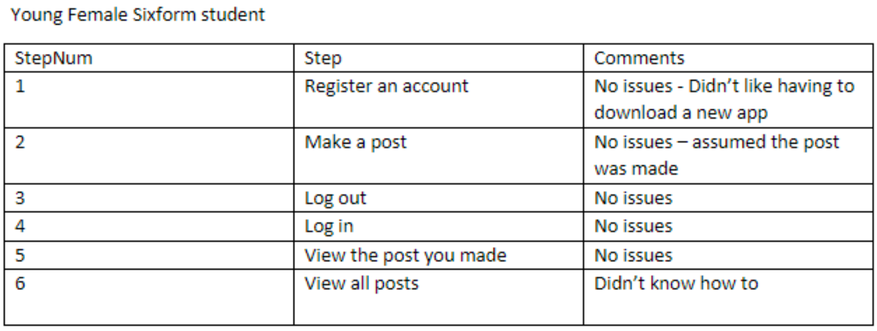
This website was thoroughly tested using unit tests, these tests where carried out throughout development and also at the end. The final test results can be found in figure4 and it shows that all but 2 test were passed. The two tests that did not pass are failing two factor authentication (test 30) and Searching for something that does not exist (test 32). In both cases the behaviour demonstrated is valid however the user is not informed. If you get the two factor authentication code wrong at log in or registration it does not tell the user this but it does not log the user in either. If the user searches for a title that has no results, the user is not told that nothing could be found but nothing is displayed either.



Female Adult

StepNum	Step	Comments
1	Register an account	No issues
2	Make a post	Doesn't know if the post was made
3	Log out	No issues
4	Log in	No issues
5	View the post you made	No issues
6	View all posts	Didn't know how to Guessed correctly – Not intuitive

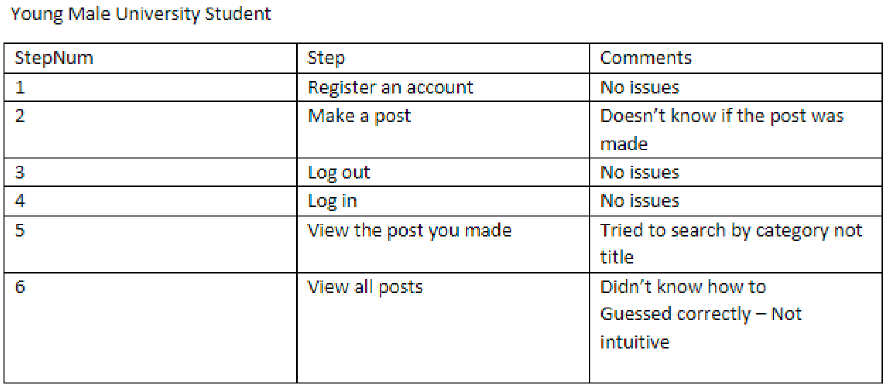
Figure 1: Female Adult



Young Female Sixform student

StepNum	Step	Comments
1	Register an account	No issues - Didn't like having to download a new app
2	Make a post	No issues – assumed the post was made
3	Log out	No issues
4	Log in	No issues
5	View the post you made	No issues
6	View all posts	Didn't know how to

Figure 2: Young Female Student

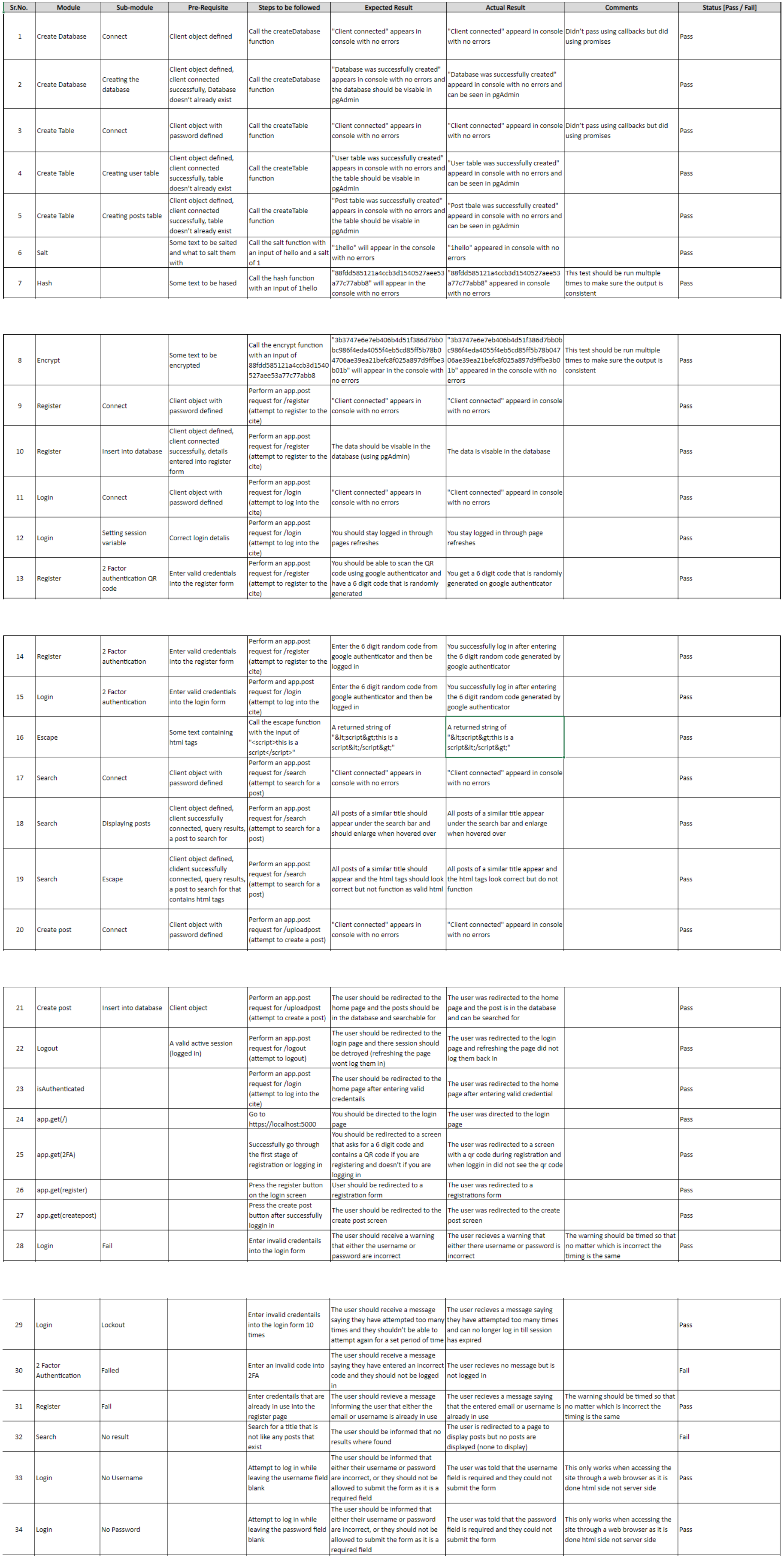


Young Male University Student

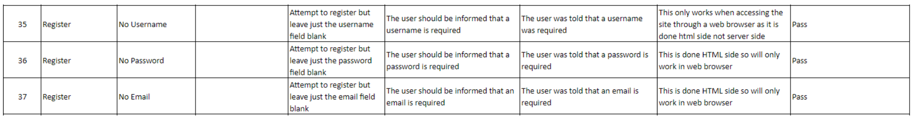
StepNum	Step	Comments
1	Register an account	No issues
2	Make a post	Doesn't know if the post was made
3	Log out	No issues
4	Log in	No issues
5	View the post you made	Tried to search by category not title
6	View all posts	Didn't know how to Guessed correctly – Not intuitive

Figure 3: Young Male Student

Figure 4: Unit Testing plan/results



Sr.No.	Module	Sub-module	Pre-Requisite	Steps to be followed	Expected Result	Actual Result	Comments	Status [Pass / Fail]
1	Create Database	Connect	Client object defined	Call the createDatabase function	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors	Didn't pass using callbacks but did using promises	Pass
2	Create Database	Creating the database	Client object defined, client connected successfully, Database doesn't already exist	Call the createDatabase function	"Database was successfully created" appears in console with no errors and the database should be visable in pgAdmin	"Database was successfully created" appeard in console with no errors and can be seen in pgAdmin		Pass
3	Create Table	Connect	Client object with password defined	Call the createTable function	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors	Didn't pass using callbacks but did using promises	Pass
4	Create Table	Creating user table	Client object defined, client connected successfully, table doesn't already exist	Call the createTable function	"User table was successfully created" appears in console with no errors and the table should be visable in pgAdmin	"User table was successfully created" appeard in console with no errors and can be seen in pgAdmin		Pass
5	Create Table	Creating posts table	Client object defined, client connected successfully, table doesn't already exist	Call the createTable function	"Post table was successfully created" appears in console with no errors and the table should be visable in pgAdmin	"Post tbale was successfully created" appeard in console with no errors and can be seen in pgAdmin		Pass
6	Salt		Some text to be salted and what to salt them with	Call the salt function with an input of hello and a salt of 1	"1hello" will appear in the console with no errors	"1hello" appeared in console with no errors		Pass
7	Hash		Some text to be hased	Call the hash function with an input of 1hello	"88fdd585121a4ccb3d1540527aee53a77c77abb8" will appear in the console with no errors	"88fdd585121a4ccb3d1540527aee53a77c77abb8" appeared in console with no errors	This test should be run multiple times to make sure the output is consistent	Pass
8	Encrypt		Some text to be encrypted	Call the encrypt function with an input of 88fdd585121a4ccb3d1540527aee53a77c77abb8	"3b3747e6e7eb406b4d51f386d7bb0bc986f4eda4055f4eb5cd85ff5b78b04706ae39ea21befc8f025a897d9ffbe3b01b" will appear in the console with no errors	"3b3747e6e7eb406b4d51f386d7bb0bc986f4eda4055f4eb5cd85ff5b78b04706ae39ea21befc8f025a897d9ffbe3b01b" appeared in the console with no errors	This test should be run multiple times to make sure the output is consistent	Pass
9	Register	Connect	Client object with password defined	Perform an app.post request for /register (attempt to register to the cite)	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors		Pass
10	Register	Insert into database	Client object defined, client connected successfully, details entered into register form	Perform an app.post request for /register (attempt to register to the cite)	The data should be visable in the database (using pgAdmin)	The data is visable in the database		Pass
11	Login	Connect	Client object with password defined	Perform an app.post request for /login (attempt to log into the cite)	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors		Pass
12	Login	Setting session variable	Correct login detalis	Perform an app.post request for /login (attempt to log into the cite)	You should stay logged in through pages refreshes	You stay logged in through page refreshes		Pass
13	Register	2 Factor authentication QR code	Enter valid credentials into the register form	Perform an app.post request for /register (attempt to register to the cite)	You should be able to scan the QR code using google authenticator and have a 6 digit code that is randomly generated	You get a 6 digit code that is randomly generated on google authenticator		Pass
14	Register	2 Factor authentication	Enter valid credentials into the register form	Perform an app.post request for /register (attempt to register to the cite)	Enter the 6 digit random code from google authenticator and then be logged in	You successfully log in after entering the 6 digit random code generated by google authenticator		Pass
15	Login	2 Factor authentication	Enter valid credentials into the login form	Perform and app.post request for /login (attempt to log into the cite)	Enter the 6 digit random code from google authenticator and then be logged in	You successfully log in after entering the 6 digit random code generated by google authenticator		Pass
16	Escape		Some text containing html tags	Call the escape function with the input of "<script>this is a script</script>"	A returned string of "<script>this is a script</script>"	A returned string of "<script>this is a script</script>"		Pass
17	Search	Connect	Client object with password defined	Perform an app.post request for /search (attempt to search for a post)	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors		Pass
18	Search	Displaying posts	Client object defined, client successfully connected, query results, a post to search for	Perform an app.post request for /search (attempt to search for a post)	All posts of a similar title should appear under the search bar and should enlarge when hovered over	All posts of a similar title appear under the search bar and enlarge when hovered over		Pass
19	Search	Escape	Client object defined, clident successfully connected, query results, a post to search for that contains html tags	Perform an app.post request for /search (attempt to search for a post)	All posts of a similar title should appear and the html tags should look correct but not function as valid html	All posts of a similar title appear and the html tags look correct but do not function		Pass
20	Create post	Connect	Client object with password defined	Perform an app.post request for /uploadpost (attempt to create a post)	"Client connected" appears in console with no errors	"Client connected" appeard in console with no errors		Pass
21	Create post	Insert into database	Client object	Perform an app.post request for /uploadpost (attempt to create a post)	The user should be redirected to the home page and the posts should be in the database and searchable for	The user was redirected to the home page and the post is in the database and can be searched for		Pass
22	Logout		A valid active session (logged in)	Perform an app.post request for /logout (attempt to logout)	The user should be redirected to the login page and there session should be detroyed (refreshing the page wont log them in)	The user was redirected to the login page and refreshing the page did not log them back in		Pass
23	isAuthenticated			Perform an app.post request for /login (attempt to log into the cite)	The user should be redirected to the home page after entering valid credentails	The user was redirected to the home page after entering valid credential		Pass
24	app.get(/)			Go to https://localhost:5000	You should be directed to the login page	The user was directed to the login page		Pass
25	app.get(2FA)			Successfully go through the first stage of registration or logging in	You should be redirected to a screen that asks for a 6 digit code and contains a QR code if you are registering and doesn't if you are logging in	The user was redirected to a screen with a qr code during registration and when loggin in did not see the qr code		Pass
26	app.get(register)			Press the register button on the login screen	User should be redirected to a registration form	The user was redirected to a registrations form		Pass
27	app.get(createpost)			Press the create post button after successfully loggin in	The user should be redirected to the create post screen	The user was redirected to the create post screen		Pass
28	Login	Fail		Enter invalid credentails into the login form	The user should receive a warning that either the username or password are incorrect	The user recieves a warning that either there username or password is incorrect	The warning should be timed so that no matter which is incorrect the timing is the same	Pass
29	Login	Lockout		Enter invalid credentails into the login form 10 times	The user should receive a message saying they have attempted too many times and they shouldn't be able to attempt again for a set period of time	The user recieves a message saying they have attempted too many times and can no longer log in till session has expired		Pass
30	2 Factor Authentication	Failed		Enter an invalid code into 2FA	The user should receive a message saying they have entered an incorrect code and they should not be logged in	The user recieves no message but is not logged in		Fail
31	Register	Fail		Enter credentails that are already in use into the register page	The user should revieve a message informing the user that either the email or username is already in use	The user recieves a message saying that the entered email or username is already in use	The warning should be timed so that no matter which is incorrect the timing is the same	Pass
32	Search	No result		Search for a title that is not like any posts that exist	The user should be informed that no results where found	The user is redirected to a page to display posts but no posts are displayed (none to display)		Fail
33	Login	No Username		Attempt to log in while leaving the username field blank	The user should be informed that either their username or password are incorrect, or they should not be allowed to submit the form as it is a required field	The user was told that the username field is required and they could not submit the form	This only works when accessing the site through a web browser as it is done html side not server side	Pass
34	Login	No Password		Attempt to log in while leaving the password field blank	The user should be informed that either their username or password are incorrect, or they should not be allowed to submit the form as it is a required field	The user was told that the password field is required and they could not submit the form	This only works when accessing the site through a web browser as it is done html side not server side	Pass



35	Register	No Username		Attempt to register but leave just the username field blank	The user should be informed that a username is required	The user was told that a username was required	This only works when accessing the site through a web browser as it is done html side not server side	Pass
36	Register	No Password		Attempt to register but leave just the password field blank	The user should be informed that a password is required	The user was told that a password is required	This is done HTML side so will only work in web browser	Pass
37	Register	No Email		Attempt to register but leave just the email field blank	The user should be informed that an email is required	The user was told that an email is required	This is done HTML side so will only work in web browser	Pass

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[1] Harris Poll. Online security survey. https://services.google.com/fh/files/blogs/google_security_infographic.pdf, 2019.

[2] Doug Bonderud. Two-factor authentication statistics. Two-FactorAuthenticationStatistics|Persona(withpersona.com), 2023.