Verification and Validation Report: Software Engineering

Team #22, TeleHealth Insights
Mitchell Weingust
Parisha Nizam
Promish Kandel
Jasmine Sun-Hu

March 10, 2025

1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test

[symbols, abbreviations or acronyms – you can reference the SRS tables if needed —SS]

Contents

List of Tables

List of Figures

This document contains the team's verification and validation report for the TeleHealth Insights project. This document features functional requirements evaluation, nonfunctional requirements evaluation, unit testing, changes due to testing, automated testing, trace to requirements, trace to modules, and code coverage metrics.

3 Functional Requirements Evaluation

The following section covers all the functional requirements tests specified in the project's VnV Plan document. The coverage can be traced in Table X.

3.1 Authentication

The test results below focus on ensuring users can safely and securely login, create and access their accounts without worrying about others accessing their information.

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output: The actual result is the Parent account role is selected and User is brought to the Parent login screen

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A1

Test Case Identifier: FR-ST-A2

Input: Selection of Clinician account role for login

Expected Output: The expected result is the Clinician account role is selected and User is brought to the Clinician login screen

Actual Output: The actual result is the Clinician account role is se-

lected and User is brought to the Clinician login screen

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A1

Test Case Identifier: FR-ST-A3

Input: Selection of 'Create Account', with a username that does not exist in the database, upon attempting to access the system

Expected Output: The expected result is a new Parent account is created

Actual Output: The actual result is a new Parent account is created

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A2

Test Case Identifier: FR-ST-A4

Input: Selection of 'Create Account', with a username that exists in the database, upon attempting to access the system

Expected Output: The expected result is a new Parent account fails to be created

Actual Output: The actual result is a new Parent account fails to be created

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A2

Test Case Identifier: FR-ST-A5

Input: Admin user selects option to 'Create Account', with a username that does not exist in the database, upon attempting to access the system

Expected Output: The expected result is a new Clinician account is created

Actual Output: The actual result is a new Clinician account is created

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A3

Test Case Identifier: FR-ST-A6

Input: Admin user selects option to 'Create Account', with a username that exists in the database, upon attempting to access the system

Expected Output: The expected result is a new Clinician account fails to be created

Actual Output: The actual result is a new Clinician account fails to be created

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A3

Test Case Identifier: FR-ST-A7

Input: Unique username and corresponding password that exists in the database

Expected Output: The expected result is a successful login to a user's account

Actual Output: The actual result is a successful login to a user's account

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A4

Test Case Identifier: FR-ST-A8

Input: Selection of 'logout'

Expected Output: The expected result is a successful logout from a user's account

Actual Output: The actual result is a successful logout from a user's account

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A5

3.2 Data Collection and Storage

The test cases below focus on ensuring data is collected and stored correctly. We test to make sure no identifiable information is stored in the database and we also check that all multimedia data is linked correctly to user assignment.

Test Case Identifier: FR-ST-DSC1

Input: Insertion of multimedia files into the database

Expected Output: A success message in the console for both storing and retrieving the data; the retrieved files are uncorrupted and match the original files

Actual Output: A success message in the console and a link to multimedia file

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-DSC1

Test Case Identifier: FR-ST-DSC2

Input: Insertion of a test assessment session with video, audio files, flagged occurrences, and timestamps for each assessment question

Expected Output: Creation of a JSON file containing the flagged occurrences and timestamps stored alongside the session data

Actual Output: A JSON file was created in AWS with the correct expected output

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-DSC2

Test Case Identifier: FR-ST-DSC3

Input: Attempted insertion of a record containing personally identifiable information (e.g. address)

Expected Output: The console throws an error as no such field exists for personal information

Actual Output: The database throws an invalid payload error

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-DSC3

Test Case Identifier: FR-ST-DSC4

Input: Insertion of multiple sessions, each tagged with a unique user identifier

Expected Output: All session data is stored and correctly grouped under their respective unique user identifiers

Actual Output: The database creates folders based on the unique identifiers

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-DSC4

Test Case Identifier: FR-ST-DSC5

Input: Insertion of an assessment report linked to a patient's unique identifier

Expected Output: The report is successfully stored, linked to the corresponding patient identifier

Actual Output: The assessment is put into the correct folder and is added to the JSON that links multimedia to assignment

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-DSC5

3.3 Video and Audio Data Analysis

The test cases below ensure that both video and audio data is correctly accessed, processed and stored in its respective user folder with no errors.

Test Case Identifier: FR-ST-VDA1

Input: Request by the analysis model to access video and audio data from a completed session

Expected Output: All requested videos and audio files are processed successfully with a corresponding success message logged

Actual Output: A success message in the console after video and audio are finished processing

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-ST-VDA1

Test Case Identifier: FR-ST-VDA2, FR-ST-VDA3

Input: Video and audio data containing speech disturbances, interruptions, and other irregularities for analysis

Expected Output: A JSON file is generated that records the number of disturbances

Actual Output: A JSON file is created in the correct user folder with a link to the video and contains bias timestamps

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-ST-VDA2, FR-ST-VDA3

3.4 Data Processing and Display

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A1

3.5 System Set Up

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A1

3.6 Assessment Interface

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Functional Requirement(s): FR-A1

4 Nonfunctional Requirements Evaluation

The following section covers all the nonfunctional requirements specified in the project's VnV Plan document. The coverage can be traced in Table X.

4.1 Look and Feel Requirements

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): FR-A1

4.2 Usability and Humanity

The test results below ensures that the system meets usability and humanity requirements for users to have an enjoyable and accessible experience.

Test Case Identifier: UH-ST-EOU1

Input: Users complete one full assessment using the system

Expected Output: User answers questions in the Usability Survey, and results are culminated and averaged.
Averages should be at least 'Agree' on the answer scale

Actual Output: User answers were on average at least 'Agree' on the answer scale across all rating questions in the usability survey (Figure 1, Figure 2).

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): UH-EOU1, UH-EOU2, UH-LI1, UH-UP1, UH-AR

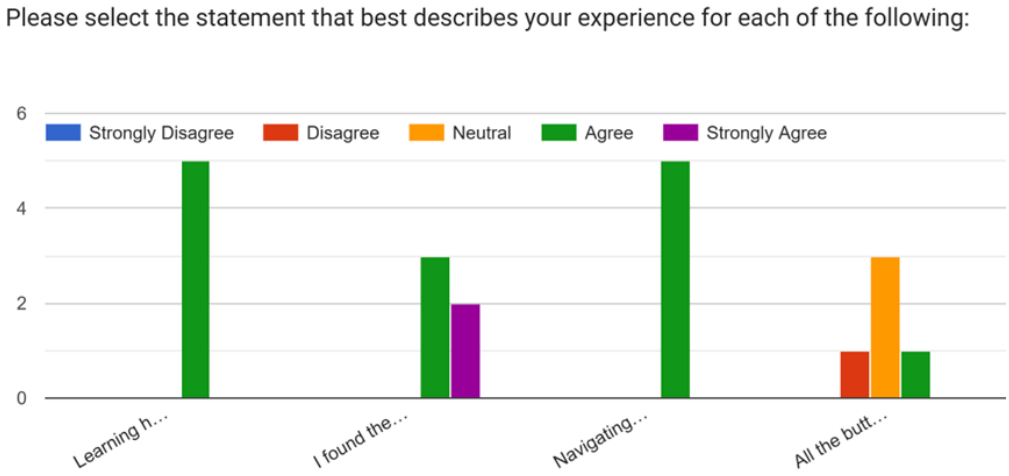

Figure 1: Results of Usability Survey - 1

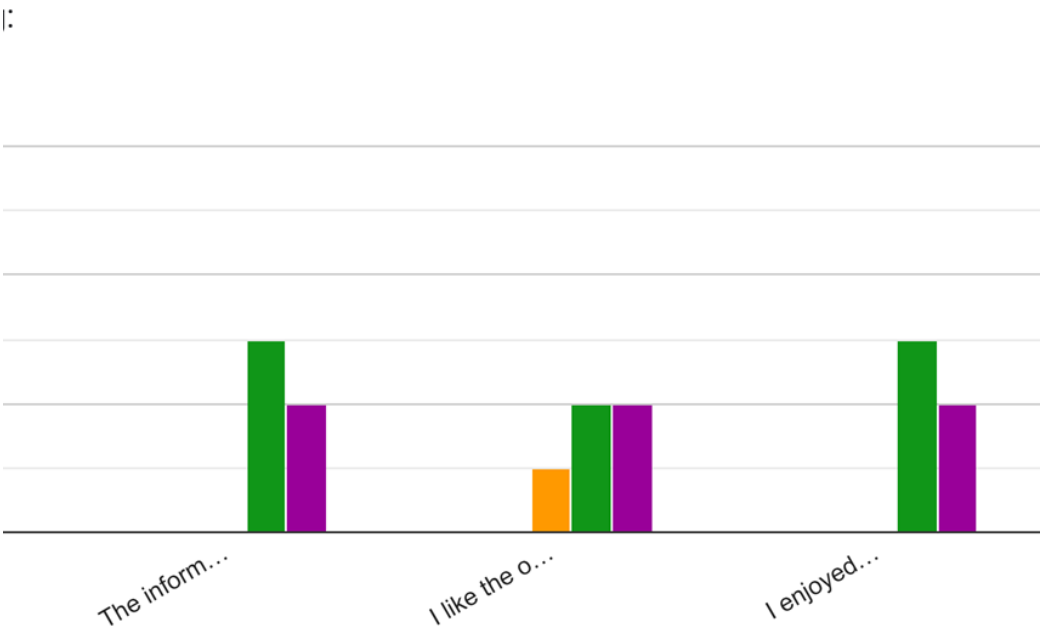

Figure 2: Results of Usability Survey - 2

Test Case Identifier: UH-ST-PI1

Input: List of available languages to perform assessments in is available to be selected and listed

Expected Output: The expected result is the available languages for the assessment are English and Mandarin

Actual Output: The assessment can be completed in either English and Mandarin (Figure 3)

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): UH-PI1

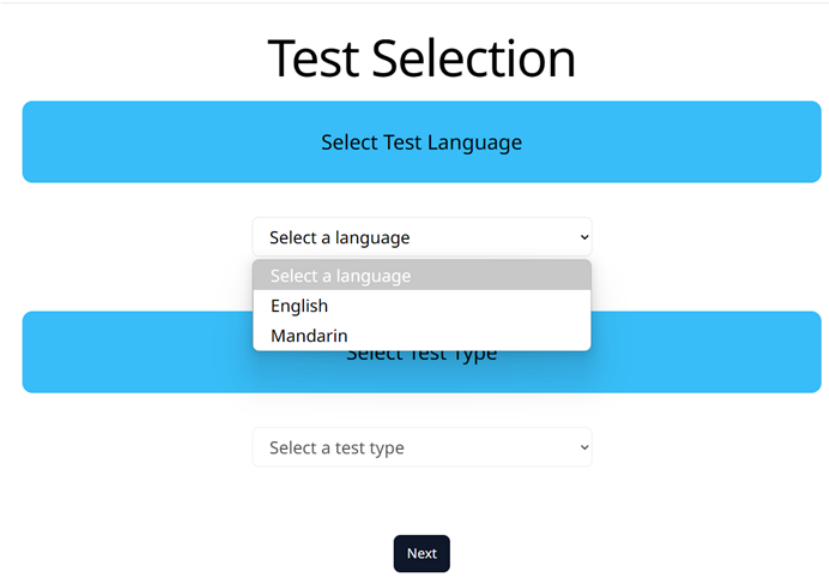

Figure 3: Language Selection

Test Case Identifier: UH-ST-LI1

Input: Link to documentation is available on the system's frontend interface, and can be accessed

Expected Output: The expected result is a user can verify the link takes them to access documentation

Actual Output: No user documentation is linked to the current version of the system

Expected and Actual Output Match: False

Relevant Nonfunctional Requirement(s): UH-LI2

4.3 Performance

The test cases outlined below ensure proper performance and stability of our system and database.

Test Case Identifier: PR-ST-SL1

Input/Condition: User navigates through various web pages.

Expected Output/Results: All web pages load completely with all functionalities within MAX_LOAD_TIME.

Actual Output/Results: All web pages load with correct data within MAX_LOAD_TIME.

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-SL1

Test Case Identifier: PR-ST-SL2

Input/Condition: A session is recorded during which two faces appear and a keyword is said.

Expected Output/Results: The latency between video and recorded playback remains below SHORT_PROCESSING_TIME.

Actual Output/Results: The latency is within the SHORT_PROCESSING_TIME when reviewing on clinician side

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-SL2

Test Case Identifier: PR-ST-SL3

Input/Condition: A video recorded during an assessment session is stored and later retrieved.

Expected Output/Results: The retrieved video meets or exceeds AVERAGE_RESOLUTION.

Actual Output/Results: Video is AVERAGE_RESOLUTION

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-SL3

Test Case Identifier: PR-ST-PA1

Input/Condition: Analysis model loaded with sample audio and video data containing known speech disturbances and multiple faces.

Expected Output/Results: The model detects speech and multiple faces with an accuracy of VERY_HIGH_SUCCESS_RATE.

Actual Output/Results: The model detects multiple faces with VERY_HIGH_SUCCESS_RATE but not speeches

Expected and Actual Output Match: False

Relevant Functional Requirement(s): PR-ST-PA1

Test Case Identifier: PR-ST-PA3

Input/Condition: User performs actions in the recorded session

Expected Output/Results: The timestamps delay within SHORT_PROCESSING_TIME of the real-time action.

Actual Output/Results: The timestamps delay SHORT_PROCESSING_TIME

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-PA3

Test Case Identifier: PR-ST-PA4

Input/Condition: Manual verification of the answer key's accuracy.

Expected Output/Results: The expected output is that the answer key is
MAX_SUCCESS_RATE.

Actual Output/Results: The answer key is MAX_SUCCESS_RATE.

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-PA4

Test Case Identifier: PR-ST-RFT1

Input/Condition: Simulate common user errors (e.g., invalid inputs).

Expected Output/Results: The system displays clear error messages for at least VERY_HIGH_SUCCESS_RATE of the errors encountered.

Actual Output/Results: System gives correct feedback to user with a VERY_HIGH_SUCCESS_RATE

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-RFT1

Test Case Identifier: PR-ST-RFT2

Input/Condition: Monthly data backup event.

Expected Output/Results: The expected output is that the system performs a data backup within a MONTHLY_BACKUP timeframe on the first of each month.

Actual Output/Results: This test case is currently out of scope as we don't have enough data to verify it.

Expected and Actual Output Match: N/A

Relevant Functional Requirement(s): PR-ST-RFT2

Test Case Identifier: PR-ST-CR1

Input/Condition: System loaded with MIN_USERS accounts.

Expected Output/Results: The expected result is that the system operates stably and manages all accounts without issues.

Actual Output/Results: System runs smoothly with MIN_USERS accounts

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-CR1

Test Case Identifier: PR-ST-CR2

Input/Condition: Data stored in the database approaches the annual MIN_STORAGE threshold.

Expected Output/Results: The system accommodates the data volume without performance degradation.

Actual Output/Results: The system accommodates the MIN_STORAGE threshold with room to increase data storage

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-CR2

Test Case Identifier: PR-ST-SE1

Input/Condition: Increase user base by YEARLY_INCREASE_PERCENTAGE.

Expected Output/Results: The expected result is that the system maintains performance while handling user growth.

Actual Output/Results: This test case is currently out of scope due to time constraints

Expected and Actual Output Match: N/A

Relevant Functional Requirement(s): PR-ST-SE1

Test Case Identifier: PR-ST-LR1

Input/Condition: Monitor system stability over successive updates on the release build.

Expected Output/Results: The system's failure rate remains below LOW_FAILURE_RATE during updates.

Actual Output/Results: system failure rate remains below LOW_FAILURE_RATE during deployment of versions

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-LR1

Test Case Identifier: PR-ST-LR2

Input/Condition: The system is run on multiple operating systems (Windows, macOS).

Expected Output/Results: The system functions correctly on all tested platforms without issues.

Actual Output/Results: The system functions correctly on multiple operating systems

Expected and Actual Output Match: True

Relevant Functional Requirement(s): PR-ST-LR2

4.4 Operational and Environmental

The test results below ensures that the system can be used in a variety of environments, along with the requirements for which users are expected to use the system within, and the capabilities and qualities the system has to interact with adjacent systems in the environment.

Test Case Identifier: OE-ST-EPE1

Input: Testing the system, including the assessment, on a variety of screen sizes

Expected Output: The expected result is the system's displayed elements will scale appropriately to different screen sizes

Actual Output: The actual result is the system's displayed elements scaled, to the satisfaction of 60% of users (Figure 4)

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): OE-EPE1

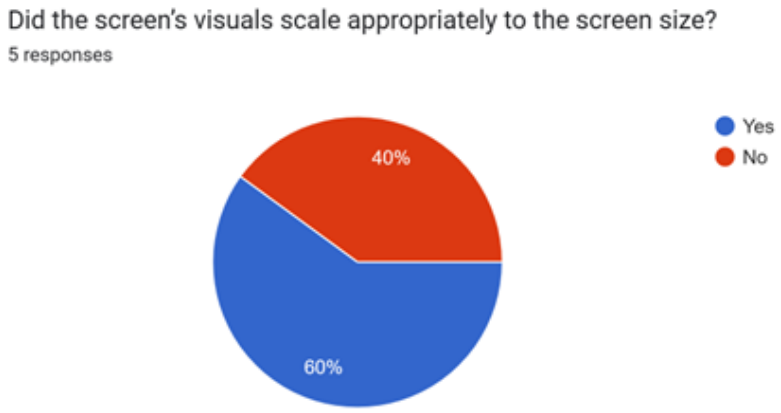

Figure 4: Results of Usability Survey - Scalability

Test Case Identifier: OE-ST-WE1

Input: User attempts to start system setup

Expected Output: The expected result is device verification displayed on-screen, informing the user that the environment they're in is suitable for the assessment

Actual Output: The actual result is the system verifies the user can proceed to the assessment following system setup, and allowing the user to test out their peripherals prior to starting the assessment (Figure 5)

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): OE-WE1, OE-WE2

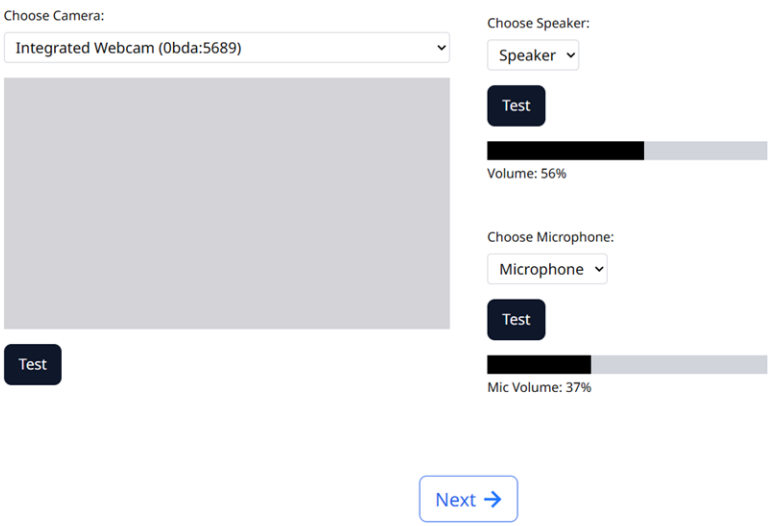

Figure 5: Device Setup

Test Case Identifier: OE-ST-IA1

Input: Assessment is complete, and results need to be stored

Expected Output: Verify results are stored in the external server

Actual Output: Results can be accessed through the server to ensure data has been uploaded and stored successful (Figure 6 and Figure 7)

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): OE-IA1

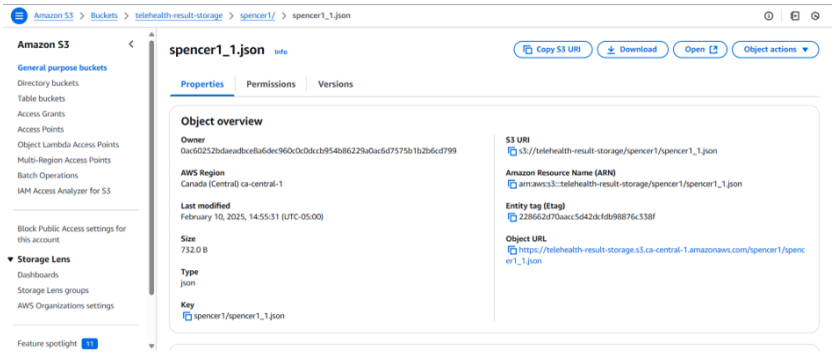

Figure 6: Results Storage - AWS

```
{
  "assessment_id": 1,
  "date": "2025-02-10",
  "questionBankId": "english-matching",
  "results": [
    {
      "question_id": 5,
      "user_answer": "a",
      "bias_state": false,
      "mark_state": "Undetermined"
    },
    {
      "question_id": 1,
      "user_answer": "a",
      "bias_state": false,
      "mark_state": "Undetermined"
    },
    {
      "question_id": 4,
      "user_answer": "c",
      "bias_state": false,
      "mark_state": "Undetermined"
    },
    {
      "question_id": 2,
      "user_answer": "a",
      "bias_state": false,
      "mark_state": "Undetermined"
    },
    {
      "question_id": 3,
      "user_answer": "b",
      "bias_state": false,
      "mark_state": "Undetermined"
    }
  ]
}
```


Figure 7: Results Storage - JSON

4.5 Maintainability and Support

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): FR-A1

4.6 Cultural

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): FR-A1

4.7 Security

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): FR-A1

4.8 Compliance

The test cases below

Test Case Identifier: FR-ST-A1

Input: Selection of Parent account role for login

Expected Output: The expected result is the Parent account role is selected and User is brought to the Parent login screen

Actual Output:

Expected and Actual Output Match: True

Relevant Nonfunctional Requirement(s): FR-A1

5 Comparison to Existing Implementation

As this project does not have existing implementations, this section is not appropriate for the TeleHealth Insights project.

6 Unit Testing

7 Changes Due to Testing

Throughout testing, important changes to the system were identified that will be implemented into Revision 1. Feedback is based on pilot usability testing with fellow software engineering students, graduates from McMaster, and the team's supervisor, following the Revision 0 demo. The changes identiifed are aimed at enhancing the functionality and usability of the system.

- **Parent Results Accessibility** Inititally, the system was not capable of displaying the results to the parents. Upon conversations with the team's supervisor, it became clear that a missing feature that would benefit users of the system is for parents to have access to their own

past assessment information. Clarity in communication surrounding their child's results is integral for conversation amongst parents and clinicians to see how the child's progress overtime.

- **Uploading Results Require Clearer Communication** Initially, to upload results, the user would press a 'submit' button on the last question of their assessment. Upon clicking this button, text would appear to inform the user that their results were being uploaded. However, feedback from the team's usability testing revealed that users would appreciate a loading screen, or a loading indicator on the screen, rather than static text to effectively communicate that results are still being uploaded. Users were previously confused on whether or not the system was operating properly, or if it froze, due to the lack of a loading indicator.
- **Simplify Tutorials** The tutorial screens consisted of a variety of screenshots and descriptions, informing users of what they could expect to see from the system upon completion of the tutorial. However, upon conducting usability testing, numerous users were confused by the tutorial, and thought that the screenshots themselves were interactable buttons, as they were screenshots of the system. Tutorials will be modified to convey integral information to the user about the assessment itself, and minimize repetition of information by reducing screenshots of the system. The section of the tutorial users appreciated was the step-by-step walkthrough of a sample question. The tutorial will be reformulated to put a larger emphasis on walking users through the system, instead of displaying static information.
- **Uploading Assessment Videos** The team's supervisor expressed through feedback that the system was not effective at uploading assessment videos. Upon inspection, the team updated the deployed system to allow for faster upload speeds, resulting in a better user experience when completing assessments. This is of particular importance to the team, as the full assessment will be 30 questions, while the usability test featured only 5 questions. In addition, the system will be used by children, which may lengthen the assessment duration as well.

8 Automated Testing

8.1 Linters

To maintain a good coding standard, we integrated linters into our development workflow. For JavaScript files, we rely on Prettier to automatically format code, ensuring consistent indentation and spacing. By running Prettier as part of our pre-commit checks, any formatting concerns are addressed before merging into our main repository, which helps minimize merge conflicts and maintain a clean codebase.

8.2 Unit Testing

We use Jest as our primary JavaScript testing framework to automatically verify critical parts of our code before changes are merged into the main branch. This approach helps us catch issues early, maintain code quality, and keep the overall system stable.

8.3 Continuous Integration

We used continuous integration (CI) pipeline to automate test execution and provide immediate feedback whenever new code is committed. We configure GitHub Actions trigger to run our Jest unit tests, linters and document tests on each pull request or direct push to main, ensuring that only code meeting quality standards is always met.

9 Trace to Requirements

10 Trace to Modules

11 Code Coverage Metrics

This section covers the code coverage metrics summary for all files in our backend. The code coverage values are given as percentages of code covered utilizing Jest. Services such as authenticaition-service and media-processing-service have greater code coverage as they were a bigger part of our system thus we wrote more unit tests for them.

File	Stmts (%)	Stmts (cov/total)	Branches (%)	Branches (cov/total)	Funcs (%)	Funcs (cov/total)	Lines (%)	Lines (cov/total)
backend	78.57	11/14	25	1/4	0	0/1	78.57	11/14
backend/routes	92.3	12/13	100	0/0	0	0/1	92.3	12/13
backend/services/authentication-service	100	9/9	100	0/0	100	0/0	100	9/9
backend/services/authentication-service/config	27.77	5/18	100	0/0	0	0/6	29.41	5/17
backend/services/authentication-service/controllers	22.97	34/148	6.25	4/64	18.18	2/11	23.28	34/146
backend/services/authentication-service/models	12.19	5/41	0	0/3	0	0/8	12.5	5/40
backend/services/authentication-service/routes	100	21/21	100	0/0	100	0/0	100	21/21
backend/services/media-processing-service	100	5/5	100	0/0	100	0/0	100	5/5
backend/services/media-processing-service/config	31.57	6/19	0	0/4	0	0/4	31.57	6/19
backend/services/media-processing-service/controllers	7.35	10/136	1.78	1/56	0	0/12	7.51	10/133
backend/services/media-processing-service/helpers	19.51	8/41	0	0/10	0	0/8	20	8/40
backend/services/media-processing-service/routes	83.33	10/12	100	0/0	0	0/2	83.33	10/12
backend/services/question-bank-service	100	5/5	100	0/0	100	0/0	100	5/5
backend/services/question-bank-service/config	84	21/25	100	1/1	100	6/6	83.33	20/24
backend/services/question-bank-service/controllers	50	22/44	31.25	5/16	80	4/5	48.83	21/43
backend/services/question-bank-service/routes	100	6/6	100	0/0	100	0/0	100	6/6
backend/services/result-storage-service	100	5/5	100	0/0	100	0/0	100	5/5
backend/services/result-storage-service/config	18.18	4/22	100	0/0	0	0/7	19.04	4/21
backend/services/result-storage-service/controllers	2.08	2/96	0	0/46	0	0/9	2.15	2/93
backend/services/result-storage-service/routes	100	10/10	100	0/0	100	0/0	100	10/10

Table 1: Code Coverage Report for Each Service

References

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Reflection.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
2. What pain points did you experience during this deliverable, and how did you resolve them?
3. Which parts of this document stemmed from speaking to your client(s) or a proxy (e.g. your peers)? Which ones were not, and why?
4. In what ways was the Verification and Validation (VnV) Plan different from the activities that were actually conducted for VnV? If there were differences, what changes required the modification in the plan? Why did these changes occur? Would you be able to anticipate these changes in future projects? If there weren't any differences, how was your team able to clearly predict a feasible amount of effort and the right tasks needed to build the evidence that demonstrates the required quality? (It is expected that most teams will have had to deviate from their original VnV Plan.)