 Marwadi University Marwadi Chandarana Group	Marwadi University Faculty of Technology Department of Information and Communication Technology	
Subject: Capstone Project (01CT0715)	Aim: Testing and Validation	
Project Documentation	Date:- 25-09-2025	Enrollment No:- 92200133030 92310133007

Testing and Validation

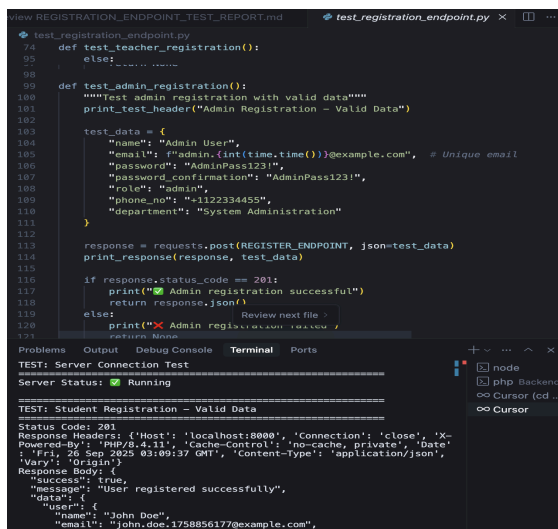
- This section details the comprehensive testing strategy employed to ensure the CodeArena platform is functional, reliable, and performant. The methodology encompasses unit testing for individual components, rigorous integration testing to validate module interactions, and real-time user acceptance testing to confirm that the system meets stakeholder requirements under realistic load conditions. The results of these tests are presented as evidence that the project has successfully met its defined objectives.

Unit Testing

As part of the project's testing strategy, unit testing was carried out to validate the correctness of individual components in isolation before full system integration. These tests focused on ensuring that backend API endpoints, frontend UI components, and the Judge0 RCE setup behaved as expected independently.

Scope:


- **Backend APIs:** Validation of request handling, business logic, and error responses in isolation. Custom Python Scripts were used to automatically test the endpoints.



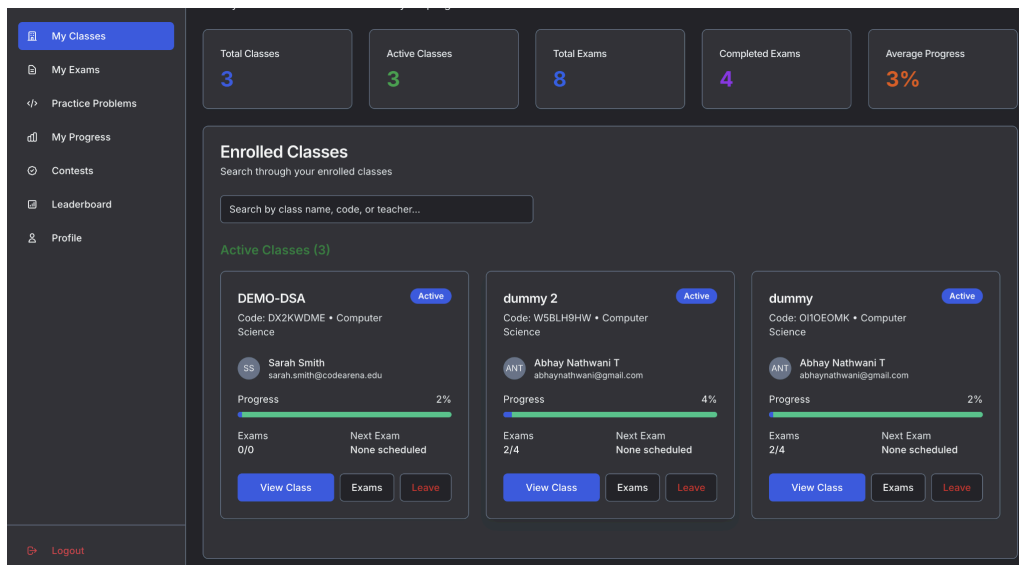
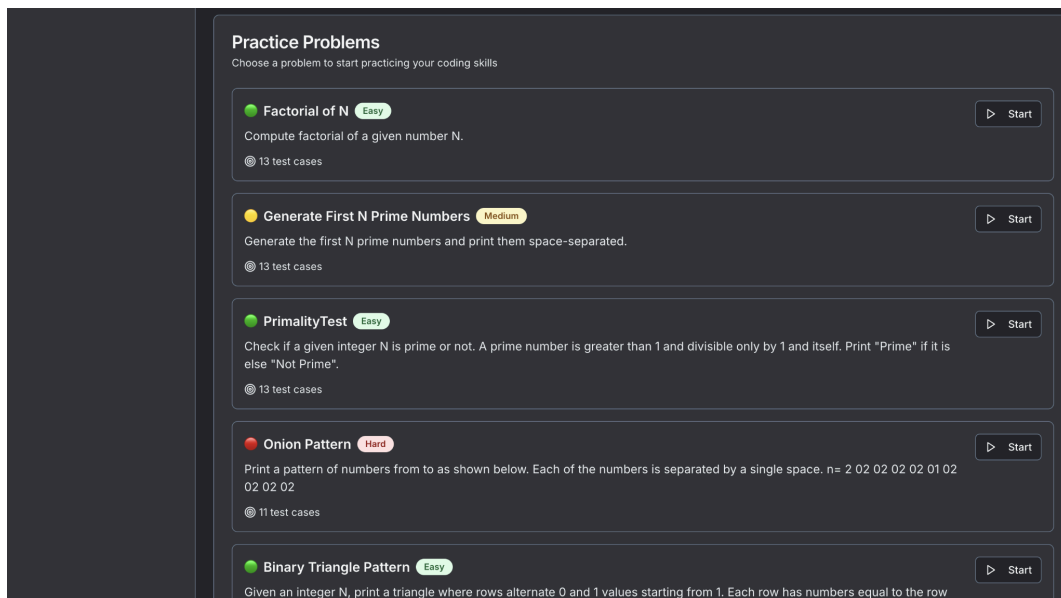
```


test_registration_endpoint.py
74 def test_teacher_registration():
95     else:
98
99 def test_admin_registration():
100     """Test admin registration with valid data"""
101     print_test_header("Admin Registration - Valid Data")
102
103     test_data = {
104         "name": "Admin User",
105         "email": f"admin.{int(time.time())}@example.com", # Unique email
106         "password": "AdminPass123!",
107         "password_confirmation": "AdminPass123!",
108         "role": "admin",
109         "phone_no": "+1122334455",
110         "department": "System Administration"
111     }
112
113     response = requests.post(REGISTER_ENDPOINT, json=test_data)
114     print_response(response, test_data)
115
116     if response.status_code == 201:
117         print("✓ Admin registration successful")
118         return response.json()
119     else:
120         print("✗ Admin registration failed")
121
122
123
Problems Output Debug Console Terminal Ports
Server Status: Running
TEST: Student Registration - Valid Data
Status Code: 201
Response Headers: {'Host': 'localhost:8080', 'Connection': 'close', 'X-Powered-By': 'PHP/8.4.11', 'Cache-Control': 'no-cache, private', 'Date': 'Fri, 26 Sep 2025 03:09:37 GMT', 'Content-Type': 'application/json', 'Vary': 'Origin'}
Response Body: {
  "success": true,
  "message": "User registered successfully",
  "data": {
    "user": {
      "name": "John Doe",
      "email": "john.doe.1758856177@example.com",
      "role": "student"
    }
  }
}

```

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- **Frontend Components:** Verification of rendering, props, state updates, and event handling for core UI modules (question display, submission forms, dashboards).

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- **Judge0 Setup:** Independent execution of sample code snippets to confirm that code is compiled, executed, and results are returned correctly without integration with other modules.

```
[Request 26/09/2025, 08:36:47] POST http://192.168.0.110:2358/submissions
{
  "source_code": "#include <stdio.h>\n\nint main(void) {\n  char name[10];\n  scanf(\"%s\\\", name);\n  printf(\"hello, %s\\n\\\", name);\n  return 0;\\n\\\"",
  "language_id": "50",
  "number_of_runs": null,
  "stdin": "Abhay",
  "expected_output": null,
  "cpu_time_limit": null,
  "cpu_extra_time": null,
  "wall_time_limit": null,
  "memory_limit": null,
  "stack_limit": null,
  "max_processes_and_or_threads": null,
  "enable_per_process_and_thread_time_limit": null,
  "enable_per_process_and_thread_memory_limit": null,
  "max_file_size": null,
  "enable_network": null
}

[Response 26/09/2025, 08:36:48] 201 Created
{
  "token": "0deec199-0e3c-4040-9268-c5d793d45f16"
}

[Request 26/09/2025, 08:36:49] GET http://192.168.0.110:2358/submissions/0deec199-0e3c-4040-9268-c5d793d45f16
[Response 26/09/2025, 08:36:50] 200 OK
{
  "stdout": null,
  "time": null,
  "memory": null,
  "stderr": null,
  "token": "0deec199-0e3c-4040-9268-c5d793d45f16",
  "compile_output": null,
  "message": null,
  "status": {
    "id": 2,
    "description": "Processing"
  }
}


[Request 26/09/2025, 08:36:51] GET http://192.168.0.110:2358/submissions/0deec199-0e3c-4040-9268-c5d793d45f16
[Response 26/09/2025, 08:36:51] 200 OK
{
  "stdout": "hello, Abhay\n",
  "time": "0.007",
  "memory": 19424,
  "stderr": null,
  "token": "0deec199-0e3c-4040-9268-c5d793d45f16",
  "compile_output": null,
  "message": null,
  "status": {
    "id": 3,
    "description": "Accepted"
  }
}
```



Integration Testing

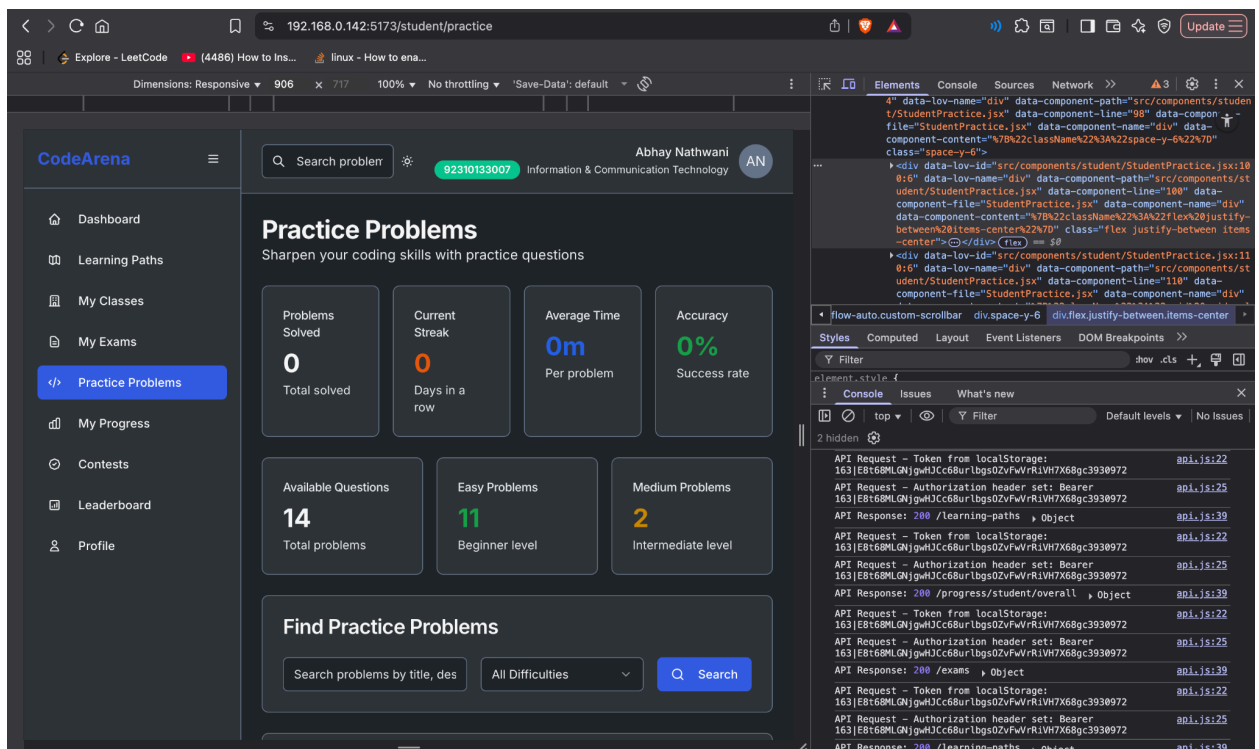
As per the project's focus, extensive integration testing was performed to ensure seamless interaction between the system's major modules. These tests validated the complete data flow between the frontend, backend, database, and the external Judge0 RCE engine.

- **Tools Used:**
 - **Postman:** For manually testing the full request-response cycle of all backend API endpoints.


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Scope of Testing:

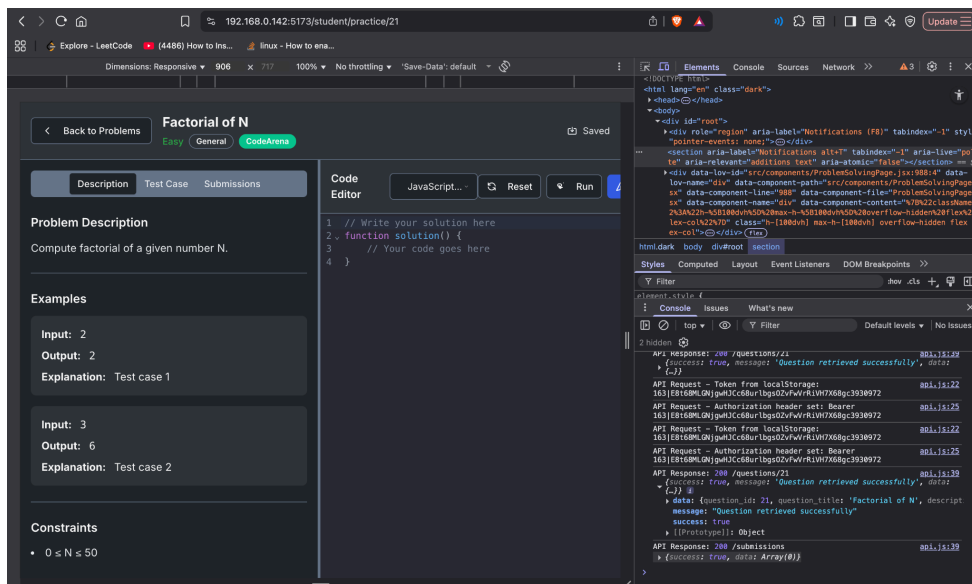
- **Frontend ↔ Backend:** Validating that user actions on the React UI correctly trigger API calls and handle the responses.



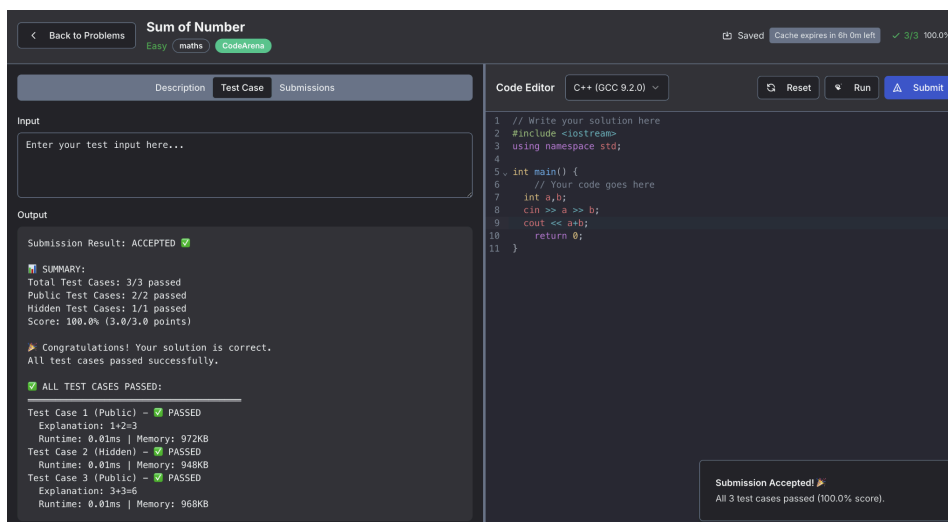
Console Logs to test API response and check proper working and flow


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- **Backend ↔ Database:** Ensuring that API endpoints correctly perform CRUD (Create, Read, Update, Delete) operations on the MySQL database.



- **Backend ↔ RCE Engine:** Verifying the critical code submission workflow, from receiving the user's code to dispatching it to Judge0 and processing the results.



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Performance Metrics

To ensure the system performs well under load, we conducted several **Real-Time User Testing** sessions. These sessions served as both **Performance/Load Tests** and **User Acceptance Tests (UAT)**. We organized three sessions with controlled groups of concurrent users (5, 15, and 30 users) submitting code and browsing the platform simultaneously.

Judge0 Load Testing Calculations :-

Test


$t = 100$ → Each test case: 1%.
 $b = 20$ | $\#(\text{batches}) = 5$ → w workers thread, $w = 5$.
 → 1 batch time → 20s
 → Time for 1 student = 20s.
 batch size = 100. → $\#(\text{batch}) = 1$.
 → Runtime = 100s.

t no. of test cases. , w worker.
 batch size : b . → $\#(\text{batches}) = t/b$.
 ⇒ Runtime (1 batch) = b sec.

run on
Eg. → $\lceil t/(bw) \rceil$ = No. of rounds for workers.
 ⇒ Runtime = $\lceil t/w \rceil$. ⇒ $w = \lceil t/b \rceil$
 → obser: w_{more}

Eg. $t = 100, w = 5$ → 20s
 $b = 10$ Runtime (1 batch) = 10s.
 $\#(b) = 10$ ⇒ Total = 20s.

1 student
 $t = 1500, w = 6, b = 40$ → $t/(bw) = 408$.
 $\#(b) = 38$.
 $\#(\text{shifts}) = 7$ Total Time = 2805
 Confirm
 Calc: 1500 / 6 = 250, 250 / 40 = 6.25, 6.25 * 7 = 43.75, 43.75 * 40 = 1750, 1750 + 1050 = 2800, 2800 + 5 = 2805.

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Justification of Metrics

The following metrics were chosen because they directly reflect the system's responsiveness and stability, which are critical to a positive user experience.

- **Code Submission Time (End-to-End):** The total time from when a user clicks "Submit" to when the final verdict is displayed. This is the platform's core functional performance metric.
- **Server CPU Utilization:** Tracks the load on the server to ensure the system does not become resource-constrained.

Validation Against Objectives

Project Objective	Validation Method	Evidence	Status
1. Develop a Full-Featured Web Application	User Acceptance Testing (UAT)	The platform deployed on the LAN Feedback from the 30-user test session was overwhelmingly positive regarding UI/UX and functionality.	Pass
2. Integrate a Secure RCE Engine	Performance & Integration Testing	The performance tests show an average submission time of under 10-15 seconds even with 30 concurrent users, meeting our objective. Integration tests confirmed seamless and secure communication with Judge0.	Pass
3. Implement a Dynamic Problem Repository	Manual Verification & UAT	A manual count confirmed over 10 problems were successfully uploaded with testers..	Pass
4. Enable Student Practice and Performance Analytics	User Acceptance Testing (UAT)	Student testers successfully used the practice features. Faculty testers confirmed the analytics dashboard provided valuable insights..	Pass

Feedback From the Students :-

<https://docs.google.com/spreadsheets/d/1-k2fM2YmH4EjVP5Iv5ao4a9UFBFkJIVrojmWGEyiDVA/edit?usp=sharing>