Project Title

Systematic Bug Testing and Reliability Engineering for NUMUE: A Process-Driven Quality Assurance Framework

Project Description:

Background and Motivation

As digital educational platforms scale in complexity, ensuring system reliability, usability, and performance becomes critical. NUMUE, as an interactive educational platform, requires structured and measurable quality assurance mechanisms to guarantee robustness, stability, and a high-quality user experience.

Traditional ad hoc debugging approaches are insufficient for complex systems. This project proposes a systems process engineering approach to structured bug testing, combining reliability engineering, workflow modeling, root cause analysis, and empirical validation.

The goal is to design a reproducible framework for systematic bug detection, classification, prioritization, resolution, and prevention—ensuring that NUMUE achieves production-grade stability and scalability.

Research Questions

How can a structured quality assurance framework improve bug detection efficiency and resolution time in NUMUE?

What process engineering methodologies (IDEF, Lean, Agile QA cycles) best optimize the bug reporting and fixing lifecycle?

How can reliability metrics be defined and measured to quantify software quality improvements over time?

What recurring defect patterns can be identified, and how can preventive design strategies reduce future bug occurrence?

Research Objectives

Develop a formalized bug testing and classification framework

Model the current bug handling workflow

Identify structural inefficiencies and bottlenecks

Define measurable reliability and performance metrics

Implement a structured test automation and validation strategy

Produce empirical findings on defect reduction and process optimization

Methodology

This project applies systems process engineering principles to software quality assurance.

1 Process Modeling

Use IDEF (Integrated Definition) modeling to map:

- Current bug reporting workflow
- Bug triage process
- Resolution lifecycle
- Identify delays, redundancies, and bottlenecks

2 Bug Taxonomy Development

Design a structured classification system for NUMUE defects:

- Functional bugs
- UI/UX inconsistencies
- Performance issues
- Security vulnerabilities
- Compatibility errors
- Data integrity problems

Each bug will be tagged using severity and priority matrices.

3 Testing Framework Design

Develop multi-layered testing mechanisms:

- Unit testing
- Integration testing
- System testing
- Regression testing
- Stress and load testing
- Usability testing

Automation strategies will be implemented where feasible.

4 Metrics and Reliability Modeling

Define measurable KPIs:

- Mean Time to Detect (MTTD)
- Mean Time to Repair (MTTR)
- Bug Recurrence Rate
- Release Stability Index
- User-Reported Incident Rate
- System Downtime Percentage

Statistical analysis will measure quality improvement over time.

5 Root Cause & Preventive Engineering

- Apply Fishbone (Ishikawa) analysis
- Perform Pareto analysis on recurring issues
- Develop preventive coding standards and QA checklists
- Propose architectural improvements

Expected Contributions

- A structured and reproducible QA framework for NUMUE

- IDEF process models of optimized bug management workflows

- A standardized bug taxonomy for educational platforms

- Automated testing scripts and documentation

- Quantitative reliability improvement results

- A case study on reliability engineering in educational technology

Project Type

Applied Research with Engineering Implementation

The project integrates:

Reliability engineering

Systems process modeling

Empirical software quality measurement

Practical platform stabilization

Results may be suitable for submission to:

Software engineering conferences

Quality assurance and reliability workshops

Educational technology industry tracks

Internship Batch:
- **Batch 1:** May 10 to July 9, suitable for Education City students, i.e., CMUQ, TAMUQ and HBKU students
- **Batch 2:** May 31 to July 23, suitable for QU university students

Duties/Activities:

Process Analysis & Modeling

Conduct a review of existing educational technology approaches and game-based learning methodologies

Analyze Qatari curriculum requirements and identify opportunities for digitization through games

Utilize systems process engineering methodologies to map current and future state workflows

Develop IDEF (Integrated Definition) function models documenting the game development and content adaptation process

Identify bottlenecks in curriculum digitization processes—such as content adaptation challenges, technical limitations, or workflow inefficiencies—using structured root cause analysis

Apply process improvement techniques (Lean, Agile, or Kaizen principles) to overcome identified bottlenecks

Game Development

Design and develop HTML5 games aligned with Qatari curriculum objectives

Write, test, and debug programming scripts for game mechanics and user interactions

Implement interactive features that engage students and reinforce learning objectives

Ensure games are accessible, culturally appropriate, and pedagogically sound

Test game functionality and user experience, iterating based on feedback

Documentation & Dissemination

Document all development processes, challenges encountered, and solutions implemented

Prepare structured reports on process improvements and their impact on development efficiency

Create user guides and technical documentation for the games developed

Present progress updates and final deliverables to mentors and stakeholders

Prepare a comprehensive project report suitable for academic or professional dissemination

Required Skills:

- Basic proficiency in HTML, CSS, and JavaScript
- Fundamental understanding of programming logic and scripting
- Interest in educational technology and game-based learning
- Analytical thinking skills for process analysis and bottleneck identification
- Problem-solving mindset with attention to detail
- Strong written and verbal communication skills
- Ability to work collaboratively in a team environment
- Willingness to learn systems process engineering concepts (no prior experience required)

Preferred Intern Academic Level:

Sophomore, Junior, or Senior standing in Computer Science, Computer Engineering, Information Technology, or related fields. Students with interdisciplinary interests in Educational Technology, Systems Engineering, Industrial Engineering, or Process Improvement are strongly encouraged to apply.

Learning Opportunities:

- Game Development: Hands-on experience in full-cycle educational game development from concept to deployment using HTML, CSS, and JavaScript

- Systems Process Engineering: Foundational knowledge of systems process engineering principles and hands-on experience creating IDEF function models

- Bottleneck Analysis: Practical experience identifying bottlenecks in complex digitization projects using structured analysis techniques

- Process Improvement: Understanding process improvement techniques applied to educational technology

- Curriculum Digitization: Exposure to Qatari curriculum requirements and the challenges of translating educational content into digital formats

- Technical Documentation: Experience creating comprehensive documentation for both technical and non-technical audiences

- Project Management: Training in basic project management tools and methodologies for tracking progress and coordinating team efforts

- Portfolio Development: Portfolio-worthy projects demonstrating game development capabilities and process modeling skills

- Professional Networking: Connection with mentors and peers in Education City's research and educational technology ecosystem

Expected Team Size: *it is preferable to have team projects*

2-4 interns working collaboratively, with opportunities for peer learning and distributed responsibilities based on individual strengths. Team members can specialize in different areas (game development, process modeling, curriculum analysis) while contributing to the integrated project outcomes.

Mentors

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