BSE 2210 Research Dossier

Unified Student Engagement Platform (USEP)

Course name and code: BSE 2210 - Software Design

Group: One

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Executive Summary

The Unified Student Engagement Platform (USEP) addresses the critical challenge of fragmented student services in higher education. This research dossier presents a comprehensive analysis of modern software design principles, focusing on micro services architecture, cultural intelligence, accessibility, and AI integration. USEP consolidates multiple university systems into a single, intuitive platform that serves diverse student populations while maintaining security and scalability standards essential for educational institutions.

Assignment question: Part A

1. **Software design as a process and artifacts**
   The software design process is divided into 5main stages, which include

   Requirements gathering and analysis: This involves identifying a problem, defining it, and research through interviews, surveys and documentations to find the specific features the system should display user requirements and system requirements. In this case IDEA ethics such as inclusivity should be taken into consideration by allowing students from different cultures, countries to participate through the use of interviews such as Google Forms.

   High Level Designs: Involves creating an architectural overview, defining modules, data flow and interactions that can be done through micro services and monolithic architectures whilst using UML diagrams like class diagrams, use case diagrams and component diagrams amongst many.

   Detailed designs: Specifying algorithms, interface details and class diagram. For instance designing how the course registration is interlinked to exam registration and course outline modules.

   Implementation and Review: Putting into place strategies, tools and timelines for development. For example choosing Supabase, Node.js for backend.

   Testing and validation: Validating designs and code through peer reviews on GitHub, and prototype testing through platforms like Figma.

Two important design artifacts for a USEP are:

(Software artifacts refer to specific deliverables created during design.)

UML Diagram: Is a standard diagram in Unified Modelling Language used to visualize, design and document a software systems and systems design thus serving as a blueprint for creating software systems. For example, a class diagram can show the main modules like course registration, timetable, exam results, and how they connect with the learning model systems and Human Resources systems. This helps in organizing the system's functions clearly.

ADR (Architectural Decision Record): This document explains important design decisions made during the project. For example, it might record the decision to use AI for academic advising or to connect with existing LMS. ADRs help keep the team informed and make it easier to revisit decisions later.

2. Trends and Their Application to USEP
Three key trends in 2025 that fit very well with the USEP platform are:

a. Micro services Architecture: Instead of building the whole platform as one big system, the system is broken down into small, focused services that communicate via APIs such as course management, financial aid, and community events. This makes it easier to develop, update modules independently, makes unit testing easier, and fault tolerance. For example, if evolving features like loan repayment can be integrated without changing the whole system. This also improves reliability because if one service fails, the others can keep working.

b. AI Assisted Designs: Using AI in software process such as design has become inevitable throughout the technological advancement especially when developing academic collaborators. AI tools such as GitHub copilot helps validate designs, generate high quality code and recommend best practices specific for a USEP, successfully implemented even with the budget constraints.

The USEP can use AI-powered academic advising to offer personalized course suggestions based on a student's past performance or goals, help track financial aid and remind students about loan repayments. This makes the platform smarter and more helpful, saving time for both students and staff.

c. Cloud Native Designs (serveless system) and Sustainable Architecture: Building software in ways that save energy and resources is important. For USEP, this means using efficient coding practices, cloud hosting that uses renewable energy, and designing the system to handle only the needed data traffic.

Constituting development practices for distributed cloud environment such as AWS Lambda serveless system. Sustainable architecture not only helps the environment but also reduces costs for the university over time.

3. **Principle first Vs application-first**
In the principle-first approach to software design, the focus starts with defining clear, high-level principles and rules that guide the entire system's development. These principles might include user privacy, seamless integration, simplicity, or scalability. By establishing these core values early, the design ensures that all parts of the project align with the overall vision and maintain consistency. For the USEP platform, this could mean setting principles like "ensure data security in all services" or "prioritize ease of use for students." This approach helps teams make decisions quickly and consistently, as each choice is measured against the established principles.

On the other hand, the application-first approach begins by focusing on the specific features and functions the users need. The design is driven by concrete use cases such as course registration or AI-powered advising. This method prioritizes building practical solutions that work well for real users before defining general principles. For the USEP, this means designing and testing actual pages or services like timetable management or financial aid tracking first, then refining the principles based on what works best in practice. Both approaches are valuable, and combining them, helps create a platform that is both grounded in strong values and highly functional for everyday users.

4. Business case: Problem definition (fragmented services)

The current system is disoriented to an extend such that student services such as course registration, access to grades and financial information, class schedules, and notification are scattered across many separate systems. Thus creating user experience challenges such as the following:

a. Navigation complexity whereby students spend around 3.2 hours weekly finding basic information such as class schedules.
b. Lower student retention: Whereby students disengage and stop using the platform completely due to the level of complexity leading to students missing important information like exam dates, CA, updates from the school amongst many.

c. Higher operational costs involved: Scattered services mean the university is spending lots of funds to maintain the USEP fragmented platforms due to mantainence costs, and subscription costs involved.
d. Security vulnerabilities: Fragmented services mean private information like emails, passwords are exposed to malicious attacks which will cause a significant loss, difficulty in mantainence and more funds required to counter such as malicious hacks to the student services platform.

Proposed solution: USEP
Vision: A Unified Student Experience Platform consolidating all student services into one.

a. Business impact: Significant cost savings through reduced administrative overhead. Lower risk of human error in data entry and system management. Increased staff productivity and morale, since time spent on repetitive tasks is minimized.

b. Student Experience & Retention Students want convenience. A single platform that combines academic, support, and community services meets this demand. With AI-driven academic advising and real-time financial aid alerts, students get personalized, proactive support that helps them stay on track academically and financially. Community features like forums and event calendars foster inclusion and engagement, making students feel more connected.
Business impact: Improved student satisfaction leads to stronger word-of-mouth and brand reputation. Higher retention rates reduce the revenue loss from student dropouts. A connected and engaged student body contributes positively to university rankings and alumni loyalty

c. Strategic Competitiveness: Today, international students evaluate digital infrastructure alongside academic reputation. Universities without robust, integrated systems are seen as outdated. USEP makes the university globally competitive, ensuring inclusivity with multilingual interfaces, accessibility features for students with disabilities, and mobile-friendly access. These factors align with global education trends where digital-first institutions attract more diverse student populations.
Business impact: Stronger global reputation increases international enrollment. Differentiates the university in a crowded market where digital transformation is a deciding factor. Creates opportunities for partnerships with edtech firms and government education initiatives.

d. Return on Investment (ROI) Initial development and integration costs may be significant, but measurable returns appear within 3–5 years:
Lower costs from reduced system maintenance and licensing. Higher revenue from improved student retention and international recruitment. Stronger reputation leading to potential research and partnership funding. Beyond 2026, the platform is designed to scale, meaning additional services can be integrated without starting from scratch.
Business impact: Financial sustainability: investment leads to long-term value creation.
Future proofing: the university avoids repeating the cost of a full system overhaul later.

Clear justification: USEP is not an expense, but a sustainable growth driver.

Why USEP Is Worth Investing in?
When we look at the situation holistically, USEP is clearly worth the investment. It solves the immediate problem of fragmentation, which directly improves student satisfaction and reduces inefficiencies. It protects revenue by preventing student dropouts remember, every 1% increase in retention can translate into millions in tuition savings. It positions the university as an innovative, student-centered institution that is globally competitive, attracting international enrollments and strengthening its market share. Finally, it delivers a measurable ROI within a few years while aligning with leadership's long-term vision of ethical, scalable, and sustainable design. This makes USEP not just an IT project, but a strategic asset for the university's future.

5. Outsourcing Analysis

Outsourcing is the practice of contracting external individuals, teams, or companies to handle specific software development task such as designing UI/UX for students, developing or mantainence. It is essential in order to acquire lot of skills, experience or ideologies from other personnel.

Onshore Outsourcing – Contracting software development teams within the country.

Advantages: Cultural alignment, same time zone, easier communication, higher quality control

Disadvantages: Higher costs (40-60% premium), limited talent pool availability

Optimal Use: Core business logic, security-critical components, integration with existing university systems

Offshore Outsourcing- Contracting teams in other countries.

Advantages: Significant cost savings (40-60% reduction), large talent pool, 24/7 development capability

Disadvantages: Communication challenges, cultural differences, quality control complexity

Optimal Use: Development tasks, quality assurance testing, maintenance activities

Nearshore Outsourcing (Neighboring Countries) – Contracting teams within the same region or nearby countries like Zimbabwe, South Africa or Malawi.

Advantages: Moderate cost savings (20-40% reduction), cultural similarities, manageable time zones

Disadvantages: Moderate savings only, limited geographic options

Optimal Use: Ongoing development, specialized skills, support services

Recommended Hybrid Strategy for USEP- combines different outsourcing models to achieve specific business goals, allowing companies to leverage the benefits of various models.

Core Development (Onshore - 40%)*:

System architecture and design Security implementation and authentication systems

Integration with existing university infrastructure

Cultural intelligence features requiring local context

Feature Development (Nearshore - 45%):

- User interface and user experience implementation

- Mobile application development for iOS/Android

- API development and micro services implementation

- Accessibility features and WCAG compliance

Support Services (Offshore - 15%):

- Comprehensive quality assurance testing

- Performance testing and load testing

- Technical documentation and user guides

- Ongoing maintenance and minor bug fixes

5. Cultural Intelligence

Cultural Intelligence (CQ) is the ability to relate, work effectively with, and adapt to people from different cultural backgrounds. It can also be defined as the capability to function effectively in culturally diverse settings and adapt technology to serve users from different cultural backgrounds (Ang & Van Dyne, 2015). For USEP at universities such as ZUT with diverse international populations, implementing cultural intelligence addresses the varied needs of students from different countries, religions and social settings, which ensures equitable access to academic services.

Requirement 1: Multilingual User Interface

USEP implements comprehensive multilingual support serving diverse student demographics including local students and international populations from South Africa, Congo, Tanzania, Somalia, Zimbabwe, China, India, and exchange students from Europe and Asia. The platform provides:

i. Complete Interface Translation: Full platform availability in English, French, Swahili, Mandarin, Arabic, and Spanish based on institutional demographics. This includes support for some of the top languages on campus that is at ZUT; these may include English, French, Swahili, Mandarin, Bemba, Nyanja and Chewa. Incorporate sign language in course video tutorials accessed on the platform to help those with special abilities navigate successfully on the platform, which acts as a measure to ensure not only inclusivity, but also accessibility, equity and diversity as IDEA principles under CQ ethics.
ii. Right-to-Left (RTL) Text Support: Culturally appropriate layouts for Arabic and Hebrew users with proper text flow and navigation patterns
iii. Cultural Calendar Integration: Automatic display of Islamic holidays (Eid al-Fitr, Eid al-Adha), Christian holidays, traditional African celebrations, Chinese New Year, and Diwali
iv. Localized Formatting: Date/time formats (MM/DD/YYYY vs DD/MM/YYYY vs YYYY年MM月DD日), number formatting, and currency display based on cultural preferences

Technical Implementation: Utilizes i18n (internationalization localization) framework with Unicode UTF-8 encoding, enabling seamless language switching without requiring separate application versions or complex engineering. Content management system supports professional translation workflows with cultural context validation (Esselink, 2000).

Requirement 2: Accessibility (WCAG 2.1 AA Compliance)

USEP ensures digital accessibility for students with disabilities, addressing visual, motor, hearing, and cognitive impairments affecting approximately 15% of university populations:

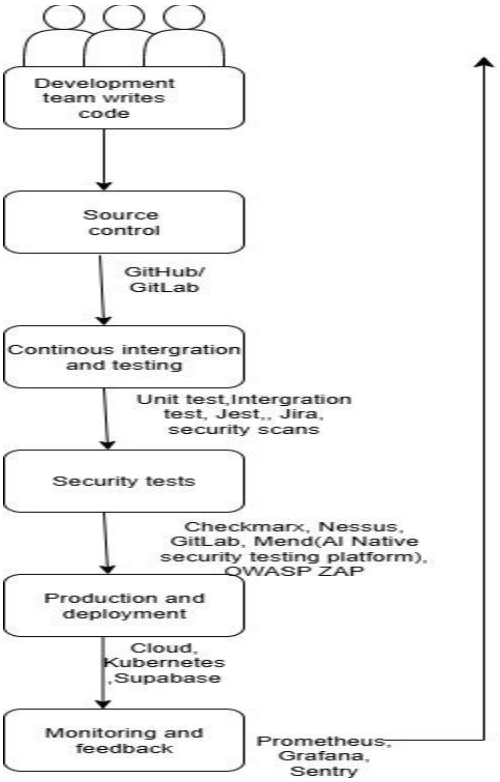
i. Screen Reader Compatibility: Accessibility features such as screen reader compatibility for visually impaired students, keyboard navigation with no mouse required such as the use of keyboard keys such as Alt, Shift+Tab, Esc to interact with digital content on the USEP, to ensure accessibility for users with mobility and visual impairments which implements ARIA labels enabling full platform navigation for visually impaired students using JAWS, NVDA, or VoiceOver

ii. Visual Accessibility Features*: High contrast mode, adjustable font sizes (up to 200% scaling), color-blind friendly design with 4.5:1 minimum contrast ratios

iii. Cognitive Accessibility: Simplified language options, consistent navigation patterns, progress indicators, and cognitive load reduction features for students with learning disabilities such as dyslexia.

These accessibility features benefit all users while ensuring legal compliance with disability rights legislation and creating inclusive educational technology (Henry et al., 2014).

6. DevOps and DevSecOps: CI/CD pipeline diagram



7. AI Awareness and opportunity

AI Opportunity: At ZUT, an AI-Powered Student Success Predictor could transform student support by analyzing attendance, assignment submissions, and platform engagement to identify struggling learners up to six weeks in advance. For international students from Tanzania, Congo, Liberia, Zimbabwe, and Somalia, who often face cultural and language barriers, AI-driven personalized study plans and multilingual chatbots would provide timely and accessible support. This not only improves academic outcomes and retention but also reduces advisor workload, creating a more inclusive and sustainable academic environment (Shaw, 2023).

Ethical Concern:The critical challenge is algorithmic bias. If trained primarily on local or historical data, the system may misinterpret the learning patterns of international or first-generation students, unfairly flagging them as at-risk. Research from Harvard highlights that unchecked algorithms can reproduce

existing inequalities and lead to discriminatory outcomes unless carefully audited (Harvard Kennedy School, 2022). To safeguard fairness, ZUT should implement bias audits, use diverse training datasets, maintain human oversight for high-stakes decisions, and establish a student-inclusive Ethics Board to ensure AI enhances equity rather than undermines it.