SOEN 6841

Winter 2024

SOFTWARE PROJECT MANAGEMENT

EDUCATIONAL GAMIFICATION PLATFORM

Phase - II

Submitted to:

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1. **Feasibility Study:** To determine gamification software's technological, financial, and operational sustainability in educational environments, a feasibility study is necessary. It estimates expenses, assesses compatibility with current infrastructure, and takes user acceptability and alignment with learning objectives into account. Stakeholders can make well-informed decisions regarding software development, resulting in successful integration and improved educational experiences, by anticipating potential risks and advantages early on.

1.1. System Overview: Brief system overview description as a point of reference for the remainder of the document. In addition, include the following:

- Responsible organization: Group 1
- System name: EduQuest
- System code: [Github Link]
- System category: Major application
- Operational status: Under development
- System Environment or Special Conditions: The software will be created to function in educational settings on the cloud (AWS), offering educators and students dynamic and captivating instructional opportunities.

1.1.1. Project References

Product Owner	Professor Joumana
POC	Meshva(Developer), Jasman(Developer), Aswiin(Developer), Anirudh(Developer)
Project Abbreviation	EQ
Documentation	[Link]

1.1.2. Acronyms and Abbreviations

Abbreviations	Meaning
POC	Points of Contact
FSR	Feasibility Study Report
GDPR	General Data Protection Regulation
CCPA	California Consumer Privacy Act
WCAG	Web Content Accessibility Guidelines

1.2. Market Feasibility

- *Industry Overview:* As per the market research and competitor analysis the education gamification industry is expanding rapidly, driven by the growing demand for digital learning solutions across various sectors. It encompasses K-12 education, higher education, corporate training, and lifelong learning, with a focus on innovation and technological advancements.
- *Competitive Landscape:* The market is moderately concentrated, with established players and startups competing for market share. Barriers to entry include high initial investment costs and the need for innovation to differentiate from competitors. Suppliers include technology providers, content creators, and educational institutions, while buyers range from schools and universities to corporations and individual learners.
- *Market Potential:* Demand for digital learning solutions is increasing due to remote learning trends and the adoption of personalized learning approaches. Niche opportunities exist in vocational training, professional development, and specialized skill-building programs. Establishing a strong brand is feasible by emphasizing innovation and quality.
- *Access to Market:* Target buyers include educational institutions, corporate training departments, online course providers, and individual learners. Marketing efforts will focus on digital advertising, content marketing, and partnerships with educational influencers. Distribution channels may include direct sales, online platforms, and integration with learning management systems.

1.2.1. Input:

- *Stakeholder Requirements:* Educators, students, administrators, and developers are among the stakeholders whose specific requirements were obtained. Market Research and analysis was carried out to see the prospective growth of the solution and competitor space.

- *Technical Specifications:*

Cloud Infrastructure	AWS for scalability, accessibility, and cost effectiveness.
Deployment Platform	AWS ECS for containers.

Frameworks and Programming Languages	Modern development frameworks and languages (e.g., Node.js, Python, Java) compatible with cloud deployment.
Database Management	AWS S3 and NoSQL to store and dump data of student profiles, learning materials, assessment results, and analytics. These also ensure data integrity, security, and compliance with data protection regulations.
AI and Machine Learning Integration	Integrate AI and machine learning algorithms for features such as generating AI based lesson plans, analyzing and predicting student growth and analytics of student progress, feedback messages, and student material recommendations. Use machine learning models for natural language processing (NLP) and large language model (LLM) to generate informational texts and questions from input data. Moreover, also creating short video graphics from texts using AI.
Video Processing and Integration	Implement video processing capabilities to generate video based questions from YouTube videos and convert text questions into short educational videos. Integrate with video hosting services and APIs for seamless video playback and management.
Collaborative Tools Integration	Integrate with collaboration platforms (e.g., Google Workspace, Microsoft Teams) for Realtime collaboration and communication among educators and students.
Accessibility Features	Implement accessibility features such as text to speech, subtitles, and color contrast adjustments to accommodate diverse learning needs. Ensure compliance with accessibility standards (e.g., WCAG) to provide inclusive learning experiences for all students.
Analytics and Reporting	Develop analytics dashboards and reporting tools for tracking student progress, skills, and areas for growth. Utilize AI and analytics algorithms to provide detailed analysis of tests, challenge levels, and adaptive learning paths for individual students.

- *Budget and Resource Allocation:* Allocate financial resources for various project needs, like cloud infrastructure, maintenance, development, and licensing costs.
- *Project schedule:* Detailed timeline and checkpoints with key milestones, deliverable dates, and all the SDLC phases.
- *Evaluation of Risk:* identifying possible risks and developing mitigation plans for them related to :

Risk Area	Mitigation Strategies
Data Security and Privacy Risks	Implement robust security measures, encryption protocols, access controls, and regular security audits. Ensure compliance with data protection regulations.
Cloud Service Reliability and Downtime	Select a reliable cloud service provider with high uptime guarantees and redundancy options. Implement failover and disaster recovery strategies to minimize downtime. Conduct performance testing and optimization. Design software architecture for scalability and elasticity. Evaluate vendor locking risks. Design software architecture for portability and interoperability.
Integration Challenges with Existing Systems	Conduct thorough compatibility assessments. Develop robust integration protocols. Provide support for industry standard interoperability standards (e.g., IMS Global LTI).
AI and Machine Learning Model Risks	Implement rigorous testing and validation processes. Regularly review and refine models to improve accuracy and fairness. Ensure transparency and explainability in AI driven features.
Budget Risk	Continuously monitor budget and develop a comprehensive budget. Regularly monitor budget expenditures and adjust forecasts. Implement cost control measures such as prioritizing features and seeking approval for budget deviations.
Time Risk	Develop a realistic project schedule with buffer time. Regularly monitor progress and identify potential bottlenecks early. Implement agile project management practices to adapt to changes and prioritize tasks effectively.
Resource Risk	Conduct regular employee feedback sessions. Develop succession plans and cross training initiatives

- *Compliance and Regulation Requirements:* adherence to industry-specific standards and data protection laws, such the CCPA and GDPR, that apply to cloud-deployed educational software.

1.2.2. Output

- *Software Deliverables:* A developed software product that is accessible through web browsers or specialized applications and is delivered on the cloud with all the features specified.
- *Documentation:* Detailed documentation that includes user guides, deployment guidelines, cloud architecture diagrams, and API documentation.
- *Training Materials:* FAQs and video tutorials that teach teachers and students how to utilize the program efficiently in a cloud setting.

- *Support Services:* Continuous cloud support services, such as software upgrades, help desk support, and debugging support for cloud deployment-related problems.
- *Testing and QA:* Testing records and QA paperwork guarantee that the program operates securely and dependably in a cloud setting.
- *Implementation Plan:* A thorough blueprint for cloud deployment that includes disaster recovery plans, data movement techniques, and configuration settings.
- *Mechanisms for Assessment and Feedback:* methods for gathering user and stakeholder input regarding the functionality, usability, and cloud infrastructure of the product.
- *Documentation of Project Closure:* documentation providing an overview of the project's results, lessons discovered, and suggestions for next iterations.

1.3. Technical Feasibility

Area	Description
Estimated No. of Users	Educators: 500+; Students: 5000+
Computation Resources	Use Amazon EC2 instances for scalable computation, and For tasks requiring parallel processing, like video processing and machine learning inference, opt for EC2 instances with GPU acceleration.
Scalability and Elasticity	Use Auto Scaling for EC2 instances and AWS Fargate for containers, allowing automatic resource scaling without infrastructure management.
Front End Technology	React.js is chosen for its component-based architecture, reusable UI elements, and strong state management. Redux and Material-UI aid development. For games, Phaser.js, Three.js, WebGL, Canvas, Box2D, Cannon.js, D3.js, Unity, and Plotly.js will handle graphics rendering, environment simulation, and data visualization.
Storage and Memory	Amazon RDS for scalable database storage with high availability and automated backups. Use Amazon S3 for storing large datasets and multimedia content, offering scalable object storage with lifecycle controls.
Networking Infrastructure	Employ Amazon Virtual Private Cloud (VPC) for secure communication. and CloudFront for content delivery across a global network with low latency.
Distributed Computing & Containerization	Use Kubernetes for container orchestration, ensuring distributed computing architecture, and Docker for consistent and portable application components. Employ batch processing through Elastic MapReduce (EMR), and frameworks like Apache Spark and Hadoop for processing large datasets if needed.

Monitoring and Optimization	Utilize AWS CloudWatch for proactive monitoring, AWS Cost Explorer and Trusted Advisor for cost optimization recommendations, and AWS Lambda for serverless computing.
Code Integration	Facilitate code integration with AWS using AWS Code Deploy and Code Pipeline for automated deployment and CI/CD pipelines. Utilize AWS CLI or SDKs for seamless integration and define infrastructure as code with AWS CloudFormation or CDK.
Security	Data encryption with AES-256 and secure connections using TLS encryption. Utilize strong access controls, multi-factor authentication (MFA), and AWS IAM for centralized identity and user management.
System Interaction	Utilize MVC architecture for smooth communication between application components. Interact with AWS services like RDS and S3 for processing and storage. Integrate with payment gateway APIs for secure transactions.

Resource Requirement:

- *Availability of Labor:* Investigate local labor market conditions, including wage rates, skill levels, and availability of qualified personnel.
- Conducting regular security audits, vulnerability assessments, and penetration testing helps identify and address potential security risks proactively, ensuring the robustness and resilience of the system against cyber threats.
- *Management Personnel:* Assess potential technical talent and leads who can execute the project and have prior industry experience.

Skill	**Tech Stack**	**Knowledge Level**
Programming	Python, Java, .NET, JavaScript	Advanced
Web Development	React, Angular, Node.js, Vue.js, Material UI, Phaser.js, Three.js, WebGL,Canvas, Box2D, Cannon.js, D3.js, Unity, Unreal Engine, Plotly.js	Advanced
Database Management	PostgreSQL, MongoDB	Intermediate
Machine Learning	TensorFlow, NLP, PyTorch	Advanced
Cloud Computing	AWS	Advanced
Package Management	npm, Yarn	Intermediate
APIs	RESTFul, GraphQL API	Advanced

Version Control	Git, GitHub	Intermediate
DevOps	Docker, Kubernetes	Intermediate
Testing	Unit testing, Integration testing, Hypothesis testing, Frontend testing	Intermediate
Agile Methodologies	Scrum, Jira	Intermediate
Communication	Effective verbal and written communication skills	Intermediate
Problem-Solving	Analytical thinking, debugging skills	Advanced
Project Management	SDLC life cycle	Intermediate
Analyst Skills	Data analysis, reporting	Intermediate

The technical requirements for the education gamification software are feasible with existing technology, notably leveraging AWS cloud services and modern development frameworks. Integration with AI/ML, video processing, collaborative tools, and accessibility features is attainable through APIs and existing libraries. With proper planning, execution, the software can be developed and deployed effectively to meet the needs of educators and students, offering a modern and scalable educational platform.

1.4. Operational Feasibility:

1.4.1. Availability and Suitability of Site:

- *Transportation:* Accessible transportation routes near urban centers for employee convenience and reduced disruptions.
- *Labor:* Availability of skilled IT professionals with competitive wages and diverse skill sets for innovation.
- *Production Inputs:* Access to essential utilities like electricity and internet for uninterrupted operations and maintain conducive work environments is provided.
- *Environmental Impact and Regulatory Requirements:* Comply with local regulations and prioritize initiatives to reduce Scope 3 emissions through cloud optimization and code efficiency.

1.4.2. Employee Operations:

- *Hiring and Training:* Recruiting and training skilled developers, data scientists, managers, and support staff are essential to build a competent workforce capable of driving innovation and delivering high-quality products.
- *Ongoing Support and Development:* Providing ongoing support, mentorship, and professional development opportunities fosters employee engagement, retention, and career advancement.

1.4.3. Technical Operations Impact Analysis:

- Potential Challenges:
  - *Integration Complexity:* Integrating the new software into existing educational workflows may pose challenges, requiring careful planning and collaboration.
  - *User Adoption:* Educators and students may need training and support for effective use, necessitating investment in comprehensive training programs and user-friendly interfaces.
  - *Technical Dependencies:* Reliance on cloud infrastructure and third-party services introduces risks to system availability and performance, mitigated by implementing contingency plans and SLAs.
  - *Data Migration:* Transferring existing data to the new system requires thorough planning, testing, and validation to ensure integrity and continuity of operations.
  - *Compliance and Regulation:* Ensuring compliance with data protection laws and standards involves establishing robust data governance practices and conducting regular compliance audits.

- Potential Benefits:
  - *Streamlined Lesson Planning:* AI-based lesson planning reduces educators' time and effort, enhancing instructional efficiency.
  - *Enhanced Learning Experience:* Features like simulation-based learning and interactive projects improve student engagement and comprehension.
  - *Data-Driven Insights:* Analytics tools offer educators valuable insights into student progress for more targeted interventions.

- *Accessibility Features:* Inclusive features accommodate diverse learning needs, promoting equitable access to education.
- *Scalability and Flexibility:* Cloud-based deployment and scalable infrastructure support future growth and innovation initiatives.

1.5. Economic Feasibility :

The economic feasibility analysis aims to evaluate the financial viability of the proposed education gamification software project. This assessment considers resource availability, potential return on investment (ROI), cost-benefit analysis, and risk considerations to provide insights into the project's economic feasibility.

Expense Category	**Estimated Cost ($)/yearly**	**Expense Category**	**Estimated Cost ($)/yearly**
Development Costs	$100,000 - $600,000+	Initial Product Rollout	$30,000
Testing Costs	$150,000	AWS Costs	$20,000
Tech infrastructure	$50,000	Storage Costs	$10,000
Office Space	$100,000	3rd Party Integration Costs	$15,000
Tech Equipment	$75,000	Licensing and Legal Fees	$25,000
Training	$20,000	Deposits	$15,000
Research and Development	$50,000	Travel	$10,000
Marketing	$200,000	Buffer Allowance	$50,000
Maintenance and Support	20% - 30% of development cost	Employee Payroll	$80,000

1.5.1. Return on Investment (ROI):

- Revenue Generation:
  - *Enterprise Version:* Offering an enterprise version for corporate training and professional development can tap into a lucrative market segment. Revenue can be generated through subscription fees and premium service offerings tailored for corporate clients.

- *Lucrative Pricing Models:* Implementing volume discounts, subscription tiers, and premium add-on services can attract a diverse customer base and increase revenue per user.
- *Webinar Platform Integration:* Partnering with industry leaders to provide a webinar platform can create additional revenue streams through sponsorships, advertising, and premium access.

- Cost Savings:
  - Implementation of AI-based features, automation, and cloud scalability can lead to cost savings in lesson planning, analytics, and infrastructure management.
  - Leveraging cloud infrastructure (AWS) and containerization technologies optimizes resource utilization, reduces maintenance overhead, and lowers operational costs compared to traditional solutions.
- Efficiency Gains:
  - Advanced marketing strategies, such as targeted advertising and content marketing, can increase brand visibility and lead generation, resulting in higher ROI on marketing investments.
  - Collaborations with universities enhance credibility, attract users, and create revenue streams through course enrollment fees and certification programs.

1.5.2. Risk Assessment:

- *Market Volatility:* Fluctuations in market demand or technological advancements may impact revenue projections and cost assumptions.
- *Regulatory Challenges:* Compliance with data protection laws and industry standards may require additional resources and ongoing monitoring.
- *Technology Risks:* Dependencies on cloud infrastructure and third-party services introduce risks related to system availability and performance.

1.5.3. Sensitivity Analysis: Conducting a sensitivity analysis to assess the project's resilience to changes in key assumptions, such as revenue growth rates, cost estimates, and market demand, is recommended. This analysis will identify critical factors driving the project's financial performance and inform risk mitigation strategies.

2. Solution Proposal

2.1. Solution Overview

2.1.1. **Problem** Traditional methods of education often struggle to engage students effectively, leading to disinterest, poor retention of knowledge, and suboptimal learning outcomes. Some common problems include:

- *Passive Learning Environment:* Traditional teaching methods often foster a passive learning environment where students are expected to listen passively to lectures without actively participating in the learning process. According to research by the National Training Laboratories, passive learning methods like lectures result in low retention rates, with students remembering only 5% of the content delivered through lectures alone. Many students find traditional lectures and textbook-based learning dull and uninspiring, resulting in disengagement and decreased motivation to learn. Moreover, Traditional teaching methods may prioritize rote memorization and standardized testing over fostering creativity and critical thinking skills. According to the World Economic Forum, creativity is listed as one of the top skills required for success in the 21st-century workforce, yet traditional educational systems often stifle creativity by emphasizing conformity and adherence to rigid curriculum standards.
- *Limited Interactivity:* Many traditional teaching approaches lack interactivity and hands-on experiences, which are crucial for engaging students and promoting deeper understanding. A study published in the Journal of Computing in Higher Education found that interactive teaching methods, such as group discussions and problem-solving activities, significantly improve student engagement and learning outcomes compared to traditional lecture-based instruction.
- *Insufficient Engagement:* Conventional teaching methods may lack interactivity and hands-on experiences, hindering students' ability to grasp complex concepts and apply theoretical knowledge to real-world scenarios. Traditional teaching methods often follow a one-size-fits-all approach, overlooking the diverse learning needs and preferences of individual students. Research published in the Journal of Educational Psychology highlights the importance of personalized instruction, indicating that students who receive personalized feedback and tailored learning experiences demonstrate higher levels of engagement and academic achievement. A report by Gallup found that only 47% of students in grades 5 through 12 feel engaged in school, indicating a widespread issue of student disengagement with traditional

teaching methods. Lack of engagement can lead to boredom, apathy, and disinterest in learning, hindering academic performance and long-term educational success.

- *Limited Use of Technology and Real-world Relevance:* Traditional teaching methods may underutilize technology, failing to leverage its potential to enhance engagement and creativity in the classroom. According to a survey conducted by the National Center for Education Statistics, only 59% of teachers reported using educational technology regularly in their instruction, suggesting a gap in integrating technology to create dynamic and interactive learning environments. Many traditional teaching approaches fail to connect classroom learning with real-world applications, making the content seem abstract and disconnected from students' everyday experiences. A study published in the Journal of Research in Science Teaching found that integrating real-world examples and hands-on activities into science education significantly increases student engagement and interest in STEM subjects.
- *Difficulty in Assessments:* Traditional assessment methods may not accurately measure students' understanding and mastery of concepts, leading to incomplete feedback and challenges in identifying areas for improvement.

2.1.2. Market Opportunity: The education gamification software presents a significant market opportunity by addressing these challenges and tapping into the growing demand for innovative, engaging, and personalized learning solutions. Key market opportunities include:

- *Rising Demand for EdTech Solutions:* The global EdTech market is experiencing rapid growth, driven by the increasing adoption of digital learning tools, especially in the wake of the COVID-19 pandemic, which has accelerated the shift towards online and hybrid learning models.
- *Focus on Student-Centered Learning*: There is a growing recognition of the importance of student-centred learning approaches that prioritize active engagement, personalized instruction, and interactive experiences, aligning with the core principles of gamification.
- *Demand for STEM Education*: With an emphasis on STEM education worldwide, there is a need for innovative learning tools that make these subjects more accessible, engaging, and relevant to students' interests and future career prospects.

- *Corporate Training and Professional Development:* Beyond the K-12 education sector, there is a significant market opportunity in corporate training and professional development, where organizations are increasingly investing in employee skill development and upskilling programs.
- *Collaboration with Industry Leaders and Universities:* Partnerships with industry leaders, universities, and educational institutions can enhance the software's credibility, expand its content library, and provide access to valuable resources, certifications, and courses.
- *Accessibility and Inclusivity:* The software's focus on accessibility features and personalized learning pathways can appeal to a wide range of learners, including those with diverse learning needs, disabilities, or language barriers, making education more inclusive and equitable.

2.2. Key Features and Functionalities :

- ***Virtual Classroom:*** Educators can utilize the virtual classroom feature to conduct engaging and interactive online classes.
  - Creation of virtual classrooms with unique links for easy student access.
  - Personalization options for educators and students, including avatar customization.
  - Integration of gamification elements such as points, badges, and leaderboards to incentivize learning.
  - Provision of a canvas for games, challenges, and assessments to enhance student engagement.
  - Classroom calendar for scheduling and managing deadlines, classes, and events.
  - Student-teacher chat functionality for seamless communication and doubt-solving.
- ***Educator Dashboard:*** The Educator Dashboard serves as a central hub for educators to efficiently manage their virtual classrooms and course materials while enhancing teaching effectiveness.
  - Access to analytics and reporting tools for tracking student progress, engagement, and retention.
  - Personalized AI-based feedback drafting to help educators provide targeted support and recommendations to students.
  - Customizable features for setting calendar events, creating custom badges, and recognizing student achievements.

- Integration with AI technology to generate engaging content, learning paths, and interactive challenges.
- Collaboration tools for organizing group activities, assignments, and peer-based learning tasks.

- ***Student Dashboard:*** The Student Dashboard is a comprehensive platform designed to enhance students' learning experiences, track their progress, and facilitate collaboration.
  - Profile customization options, including bio and avatar updates, to reflect students' interests and personality.
  - Gamification elements such as achievements, badges, and leaderboards to motivate and engage students in their learning journey
  - Visual representations of progress, skill mastery, and performance analytics to empower students to track their growth and make informed decisions.
  - Access to course materials, calendar events, and the Game Library Canvas to support learning and skill development.
  - Collaboration tools for team-based activities, as well as feedback and grades inbox for receiving actionable insights and suggestions for improvement.
- **Iteration 1 of Game Library Canvas:** The Iteration 1 of Game Library Canvas introduces a variety of engaging and interactive educational games and puzzles designed to enhance students' learning experiences and reinforce key concepts. Let's explore how students can interact with each game environment:

Puzzle Type	Scenario	Interaction	Additional Features
Escape Room or Treasure Hunt Puzzle	Progress through a virtual setting by solving challenges and puzzles.	Utilize provided hints to unlock clues and progress.	Earn badges and compete on leaderboards for motivation.
Rapid Fire / Riddles	Answer time-based questions like true/false or multiple-choice.	Race against the clock, testing knowledge and critical thinking.	Receive immediate feedback to reinforce learning and improvement.
Virtual Labs	Conduct virtual science experiments and explore concepts.	Manipulate variables to understand real-world phenomena.	Assess comprehension through quizzes and assessments.

Coding Combats	Solve coding puzzles to reinforce programming concepts.	Apply coding principles to problem-solving.	Foster teamwork and peer learning through collaboration.
Maze Runner	Navigate maze-like challenges to promote critical thinking.	Solve challenges against time or peers.	Adapt maze levels to various difficulty levels.
Memory Match	Match pairs to reinforce memory and comprehension.	Match related information for better retention.	Receive immediate feedback to refine memory and understanding.
Builders	Construct factually correct sentences to reinforce grammar.	Manipulate words for language skills enhancement.	Encourage creativity in sentence creation through open-ended prompts.
Crosswords	Solve crossword puzzles to reinforce vocabulary and concepts.	Apply knowledge to fill crossword grids.	Customize crosswords for different subjects and grades.
Scenario-based Quizzes	Respond to questions based on visual scenarios.	Analyze scenarios for real-world problem-solving.	Foster engagement by contextualizing questions within scenarios

- **Mechanism for Student Data Measurement and Display:**

1. **Data Collection:**
    - *Event Tracking:* The platform will track various student interactions within the games, including game start/finish times, level completion, scores achieved, and choices made during gameplay.
    - *User Profiles:* Each student will have a unique user profile where their progress, achievements, and performance metrics are stored.
    - *API Integration:* The platform will integrate with backend APIs to fetch and store student data securely, ensuring that it is readily available for analysis and display on the educator dashboard.
2. **Data Processing and Analysis:**
    - *Data Processing Pipeline*: Student data collected from gameplay interactions will be processed through a data pipeline, where it undergoes cleansing, transformation, and aggregation to extract meaningful insights.

- *Performance Metrics Calculation:* Performance metrics such as average scores, completion rates, time spent on tasks, and skill proficiency levels will be calculated based on the processed data.
- *Machine Learning Algorithms:* Advanced machine learning algorithms may be employed to analyze patterns in student behavior, predict learning outcomes, and personalized recommendations for each student.

3. **Dashboard Development:**
    - *Interactive Dashboards:* The educator dashboard will feature interactive visualizations and data widgets that provide a comprehensive view of student performance and progress.
    - *Customizable Views:* Educators can customize their dashboard views by selecting specific metrics, filters, or periods of interest, allowing them to focus on relevant data.
    - *Real-time Updates:* The dashboard will update in real-time or with minimal latency, ensuring that educators have access to the most current information on student performance.
    - *Role-based Access Control:* Role-based access control mechanisms will be implemented to ensure that only authorized educators can access student data on the dashboard, protecting student privacy and confidentiality.
    - *Charts and Graphs:* Various types of charts and graphs, such as bar charts, line graphs, pie charts, and scatter plots, will be used to visualize student performance metrics and trends over time.
    - *Progress Tracking:* Progress bars, gauges, and other visual indicators will be used to track student progress toward learning goals and objectives, providing a clear visual representation of their achievements.

Mechanism for Incorporating Gamification with access of this data to Students:

1. **Competition with Peers:**
    - *Leaderboards*: Display leaderboards showcasing the top-performing students based on various metrics such as scores, completion rates, or skill mastery levels. Students can see where they stand relative to their peers and strive to improve their rankings.

- *Peer Challenges:* Enable students to challenge their peers to friendly competitions or collaborative activities within the platform by making teams. They can compete in quizzes, solve puzzles, or work together on group projects, earning points and rewards for their participation and performance.

2. Unlocking Badges, Milestones, Rewards, and Achievements:

- *Badges:* Create badges to recognize student accomplishments, such as completing levels, mastering skills, or excelling in quizzes or assignments.
- *Milestones:* Signify significant progress in students' learning journeys, granting access to advanced content or privileges.
- *Rewards:* Provide virtual currency or points as rewards for students to accumulate and redeem for incentives or recognition.
- *Achievements:* Set these for students to pursue, such as completing activities or earning high scores, offering validation of their efforts.

2.3. Benefits and Impact

2.3.1. Benefits for Users and Stakeholders:

a. Educators:

- Streamlined Lesson Planning: AI-based lesson planning functionality saves educators time and effort by automating the creation of personalized lesson plans tailored to students' needs and learning objectives.
- Enhanced Teaching Effectiveness: Simulation-based learning environments and interactive activities facilitate better comprehension and engagement among students, leading to improved learning outcomes.
- Data-Driven Instruction: Access to detailed analytics and insights on student performance enables educators to identify areas for improvement, personalize instruction, and provide targeted support to students.
- Increased Efficiency: Homework generation tools and automated feedback messages streamline administrative tasks, allowing educators to focus more on teaching and student interaction.

b. Students:

- *Engaging Learning Experience:* Interactive games, simulations, and collaborative activities make learning enjoyable and immersive, fostering deeper understanding and retention of concepts.
- *Personalized Learning Paths:* Adaptive learning algorithms recommend relevant materials and generate customized questions based on students' individual progress and skill levels, ensuring personalized learning experiences.
- *Motivation and Recognition:* Gamification elements such as badges, rewards, and leaderboards incentivize students to actively participate, excel in their studies, and compete with peers in a positive manner.
- *Accessibility and Inclusivity:* Accessibility features such as text-to-speech and color contrast adjustments accommodate diverse learning needs, ensuring that all students can access and engage with the platform effectively.
- *Comprehensive Feedback:* Educators provide detailed analysis of test performance, challenge levels, and skill mastery levels to provide students with actionable feedback and insights into their strengths and areas for improvement.

Expected Impact:

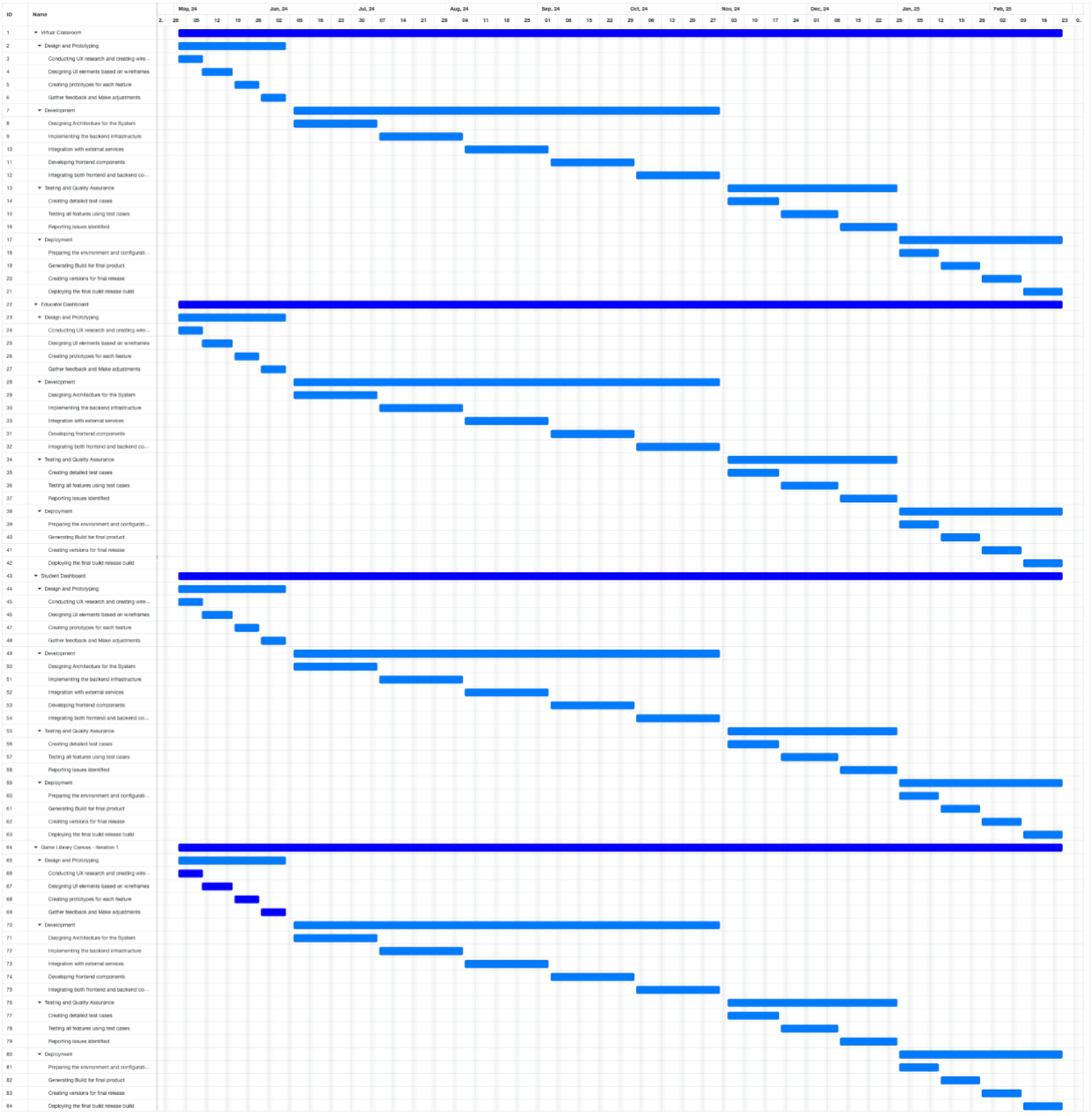
- *Improved Academic Performance:* By providing educators with tools for personalized instruction and students with engaging learning experiences, the software is expected to lead to enhanced academic performance and achievement across various subjects and topics.
- *Increased Engagement and Retention:* The interactive and gamified nature of the platform is likely to increase student engagement and motivation, leading to higher levels of participation, retention, and completion rates.
- *Enhanced Teaching Practices:* Educators can leverage data-driven insights and analytics to refine their teaching practices, implement evidence-based instructional strategies, and address individual student needs more effectively.
- *Innovation in Education*: The integration of AI, machine learning, and gamification technologies represents a significant advancement in

educational technology, driving innovation and transformation in teaching and learning practices.

- *Broader Access to Quality Education:* By offering accessible, personalized, and engaging learning experiences, the software has the potential to expand access to quality education for students worldwide, regardless of their geographic location or socio-economic background.

3. Project Plan(WBS)

3.1. Project Timeline



The project schedule, represented through a Gantt chart, outlines the project's milestones, emphasizing the major releases and their respective timeframes. The development focuses on four key components crucial for the successful initial release of the product:

- **Virtual Classroom:** A platform designed for educators to conduct interactive online classes.
- **Educator Dashboard:** A central hub empowering educators to efficiently manage virtual classrooms, and course materials, and enhance teaching effectiveness.
- **Student Dashboard:** A comprehensive platform aimed at elevating students' learning experiences, monitoring progress, and fostering collaboration.
- **Game Library Canvas - Iteration 1:** This phase introduces a diverse range of engaging and interactive educational games and puzzles, intended to enrich students' learning experiences and reinforce key concepts.

The project organizes the four major components into specific milestones, with each milestone representing a significant stage in the development process. Importantly, the development of these milestones for all four components is planned to take place simultaneously. This parallel approach aims to streamline the overall progress and ensure a cohesive advancement of each component toward its respective completion.

The initiation of the project is scheduled to commence in May 2024, progressing through a well-defined timeline until its conclusion with the release of the final product in February 2025. The project encompasses four principal phases, each dedicated to a major component, and is structured with distinct timelines for the successful completion of each phase:

- Design and Prototyping - (4 Weeks)
- Development - (16 Weeks)
- Testing and Quality Assurance - (8 Weeks)
- Deployment - (6 Weeks)

The Gantt chart visually represents the specific start and end dates for each of these phases, providing a clear and structured overview of the project's progression throughout its lifecycle.

- A detailed timeline with dates can be found in this reference link: Timeline
- Different Views of the Gantt chart and original Gantt file can be found in this reference link: Gantt

3.2. Milestones and Deliverables

3.2.1. Project Phases: The project is structured into distinct phases, each tailored to the major feature components, with specific operations assigned to each phase.

a. Design and Prototyping

During the Design and Prototyping phase, our primary objective is to establish the foundation for the project's success. We initiate this phase by conducting thorough user experience (UX) research, exploring user preferences, behaviors, and pain points in depth. This research serves as the basis for creating wireframes, which act as guides for the subsequent user interface (UI) design. Building upon these wireframes, we carefully craft UI elements, ensuring they are in line with user expectations and contribute to improved usability. Subsequently, we transition to the prototyping stage, where we bring our designs to life through interactive models that replicate the user experience. Throughout this phase, we actively engage with stakeholders and end-users, soliciting their feedback to iterate and enhance our designs, thereby ensuring they effectively address their requirements.

b. Development

In the Development phase, we transition from conceptualization to implementation, bringing our designs to life. A key aspect of this phase is designing the architecture for the system, laying the foundation for robust and scalable software. With the architecture in place, we proceed to implement the backend infrastructure, building the engine that powers the application's functionality. This involves integrating with external services and APIs to leverage existing functionalities and enhance the user experience. Simultaneously, our frontend development team crafts the user-facing components of the application, creating intuitive interfaces that seamlessly interact with the backend. Finally, we integrate these frontend and backend components, ensuring they work collectively to deliver a cohesive user experience.

c. Testing and Quality Assurance

In the Testing and Quality Assurance phase, we rigorously assess the functionality and performance of our application to ensure it meets the highest standards of quality. We begin by creating comprehensive test cases that cover all aspects of the software's functionality, from basic features to edge cases. These test cases serve as

a roadmap for our testing efforts, guiding us as we carefully examine each feature. Through thorough testing, we identify any issues or discrepancies and report them for resolution. Our goal is to ensure that the application is stable, reliable, and free of defects before proceeding to deployment.

d. Deployment

During Deployment, we prepare to unveil our product to the world, ensuring a smooth and seamless transition from development to production. We start by preparing the environment and configurations, ensuring everything is set up optimally for the application's launch. Next, we generate the final product build, compiling all the code and assets into a deployable package. We then create versions for release, carefully documenting any changes and updates. Finally, we deploy the final build, making our application available to users and stakeholders. Throughout this process, we prioritize efficiency, reliability, and transparency, aiming to deliver a polished product that exceeds expectations.

The project phases are connected, where the advancement of each subsequent stage relies on the successful completion of the preceding ones. Each phase serves as a foundation for the next, creating a sequential path that guides the project toward its ultimate completion.

3.2.2. Milestones

The development process involves dividing each component into four significant phases. These phases are organized and grouped into milestones. Within these milestones, each phase is accommodated, facilitating parallel development across the components. This structured approach ensures that the various stages of development for each component progress simultaneously, contributing to an efficient and coordinated overall development process.

- **Milestone 1:** During Milestone 1, the focus is on the Design and Prototyping phase for all four feature components. This phase involves the comprehensive design and creation of prototypes for each component. The results of Milestone 1 provide a foundational design and prototype for all components, serving as a crucial starting point for the subsequent stages of development.

- **Milestone 2:** During Milestone 2, the primary development phase for all feature components occurs. This phase entails the substantial progress of creating the entire project, including the development of all functionalities. The desired outcome at the end of this milestone is the completion of the project with fully implemented and functional features.

- **Milestone 3:** Within Milestone 3, comprehensive testing is conducted for all features of the project. This phase focuses on thoroughly assessing each feature to identify and address any issues. The ultimate goal is to achieve a finalized product with all features rigorously tested and any identified problems effectively resolved. This ensures the delivery of a robust and reliable end product, meeting the established quality standards.

- **Milestone 4:** In Milestone 4, the final deployment phase occurs, marking the conclusion of the project. During this stage, the completed product is deployed, making it accessible for end-users. This signifies the transition from development and testing to the operational phase, allowing users to utilize the finalized product for its intended purpose. The focus is on ensuring a smooth and successful deployment to enable a seamless user experience.

3.3. Resource Allocation

Different phases of the project require individuals with diverse areas of expertise. Our process involves parallel development, where all four components undergo each phase concurrently. Resource allocation for these phases is as follows:

1. **Design and Prototyping**

   UI/UX Designers - 2

   Critical Dependency: A critical dependency exists wherein UX research must be completed before proceeding to wireframe and UI design. Additionally, feedback gathering relies on the creation of prototypes.

2. **Development**

   - Software Architects - 1
   - Back-End Developers - 4 (Developers allocated for each major component)

- Front-End Developers - 2 (1 Developer allocated for each major component)
- AI Specialist -1

Critical Dependency: There's a critical dependency where architecture design must be finalized before starting backend infrastructure implementation. Furthermore, frontend development depends upon backend integration.

3. **Testing and Quality Assurance**
   - QA Engineers /Testers- 2

   Critical Dependency: A critical dependency exists where test cases must be created before testing can commence. Furthermore, testing needs to be completed before any issues can be reported.

4. **Deployment**
   - DevOps Engineers - 2
   - System Administrator – 1

   Critical Dependency: There is a critical dependency where the environment setup must be completed before generating the build. Additionally, deployment relies on the availability of the final build.

4. Risk Assessment and Mitigation

4.1. Risk Identification

4.1.1. Technical Risks:

- *Gamification Implementation Challenges:* Integrating gamification elements seamlessly into the platform may present technical hurdles, such as ensuring compatibility across devices and browsers.
- *Scalability Concerns:* As user engagement increases, scalability issues could arise, impacting the platform's performance and responsiveness.
- *Data Security:* Safeguarding user data, especially personal information collected during gameplay and assessments, from unauthorized access or breaches is critical.
- *Content Development Challenges:* Developing diverse and engaging educational games and puzzles within the platform may require specialized technical expertise and resources.

4.1.2. Operational Risks:

- *User Engagement:* Ensuring sustained user engagement with the platform and overcoming potential user resistance to gamified learning methods.
- *Content Management:* Managing and updating educational content, including games, challenges, and assessments, to keep it relevant and aligned with curriculum requirements.
- *Technical Support:* Providing adequate technical support and training to educators and students to maximize the platform's effectiveness.
- *Community Building:* Fostering a supportive and active user community to encourage collaboration, feedback, and continuous improvement.

4.1.3. Economic Risks:

- *Budget Constraints:* Balancing the costs associated with platform development, content creation, and ongoing maintenance within budgetary constraints.
- *Monetization Strategy:* Developing a sustainable monetization strategy, such as subscription models or in-app purchases, to generate revenue without compromising user experience or educational objectives.
- *Market Competition*: Responding to market competition from existing educational gamification platforms and adapting strategies to differentiate and attract users.

4.1.4. Legal and Compliance Risks:

- *Data Privacy Regulations:* Complying with data privacy regulations, such as COPPA (Children's Online Privacy Protection Act), to protect the privacy of young users and avoid legal repercussions.
- *Intellectual Property Rights:* Ensuring that all content developed for the platform respects intellectual property rights and avoiding copyright infringement issues.
- *Accessibility Compliance:* Adhering to accessibility standards, such as WCAG (Web Content Accessibility Guidelines), to ensure that the platform is usable by all learners, including those with disabilities.

4.1.5. User Experience Risks:

- *Usability Issues:* Addressing usability issues and user interface design challenges to create an intuitive and engaging learning environment.

- *Feedback Mechanisms:* Establishing effective feedback mechanisms to gather user input, identify pain points, and iteratively improve the platform based on user feedback.
- *Content Relevance:* Ensuring that educational content and gamified activities are relevant, engaging, and aligned with learning objectives to maintain user interest and motivation

4.2. Risk Impact Analysis

4.2.1. Assessment of the potential impact of each identified risk on the project:

- *Technical Risks:* Gamification implementation challenges could delay platform development, scalability concerns may affect user experience, data security breaches could erode user trust and content development challenges might limit the platform's educational effectiveness.
- *Operational Risks:* Low user engagement rates could impact platform usage, inadequate content management might lead to outdated or irrelevant educational materials, insufficient technical support could frustrate users, and a lack of community engagement may hinder platform growth.
- *Economic Risks:* Budget constraints could limit feature development, an ineffective monetization strategy might lead to revenue shortfall, market competition could affect user acquisition and retention, and economic downturns could impact user spending habits.
- *Legal and Compliance Risks:* Non-compliance with data privacy regulations may result in legal penalties, intellectual property disputes could halt platform development, accessibility compliance issues might exclude certain user groups, and legal challenges could delay or disrupt operations.
- *User Experience Risks:* Usability issues may result in user frustration and abandonment, ineffective feedback mechanisms might hinder platform improvement, and irrelevant content could lead to disengagement and dropout rates.

4.2.2. Prioritization of risks based on severity and likelihood:

- **High Priority Risks**: Risks with high severity and likelihood that could significantly impact the platform's success and viability.

- *Security Vulnerabilities:* The likelihood of security breaches in educational platforms is high due to the sensitive nature of student and educator data. The severity is also significant as data breaches can lead to legal liabilities, loss of trust, and reputational damage.
- *Integration Challenges:* Given the complexity of integrating various components such as virtual classrooms, dashboards, and game libraries, the likelihood of facing integration challenges is high. The severity is high as well since integration issues can lead to system downtime and hinder the overall functionality of the platform.

- **Medium Priority Risks**: Risks with moderate severity and likelihood that may affect project outcomes if not adequately addressed.
  - *User Adoption:* While there's a moderate likelihood of resistance to change or difficulties in user adoption, the severity is moderate as it could impact the platform's success and effectiveness in achieving learning objectives.
  - *Budget Overruns:* Although there's a moderate likelihood of budget overruns due to unforeseen expenses or resource constraints, the severity is moderate as it could strain financial resources and impact the project's economic sustainability.
- **Low Priority Risks**: Risks with low severity and likelihood that are less likely to have a significant impact but still require attention to mitigate potential consequences.
  - *Scope Creep:* While there's a low likelihood of frequent changes in project scope, the severity is relatively low as it may cause some delays and increase costs, but it's manageable with proper project management practices.
  - *Environmental Risks:* The likelihood of environmental risks such as natural disasters or power outages directly impacting the platform is relatively low. Additionally, the severity is low as these events, although disruptive, can be mitigated with contingency plans and resilient infrastructure.

4.3. Risk Mitigation Strategies

4.3.1. Development of strategies to mitigate or minimize the impact of identified risks:

- *Technical Risks:* Conduct thorough testing and prototyping, invest in scalable infrastructure, implement robust data security measures, and collaborate with experienced content developers.
- *Operational Risks:* Implement user engagement strategies, establish efficient content management processes, provide comprehensive technical support, and foster an active user community through forums and feedback channels.
- *Economic Risks:* Conduct market research to inform budget allocation, diversify monetization strategies, differentiate the platform's offerings, and establish contingency plans for economic downturns.
- *Legal and Compliance Risks:* Consult legal experts to ensure compliance with regulations, secure necessary licenses and permissions, conduct regular accessibility audits, and implement processes to address intellectual property concerns.
- *User Experience Risks:* Conduct usability testing with target users, establish feedback mechanisms for continuous improvement, regularly update content to maintain relevance, and prioritize user-centric design principles throughout development.

4.3.2. Contingency plans for addressing unforeseen challenges:

- Establishing partnerships with educational institutions, IT firms or organizations to secure additional funding or resources.
- Developing alternative revenue streams, such as sponsored content or premium features, to supplement core monetization strategies.
- Monitoring industry trends and competitor activities to adapt quickly to changing market conditions.
- Establishing legal and compliance review checkpoints throughout the development process to identify and address potential issues early.
- Regularly soliciting user feedback and conducting usability studies to identify and address user experience issues proactively.

5. Budgeting

The project is structured into several key categories to ensure a comprehensive budget breakdown, enabling efficient resource allocation and successful project execution.

5.1. Costing

5.1.1. Development Costs:

a. Frontend Development: For front-end development, resources will be dedicated to crafting an intuitive UI/UX design, ensuring ease of navigation. Responsive design principles will be implemented for accessibility across various devices, while interactive elements like animations will enhance engagement. Attention will also be given to accessibility standards and cross-browser compatibility to ensure a seamless experience for all users. Total Frontend Development Costs: $70,000

b. Backend Development: Backend Development for the Educational Gamification Platform entails:

- Coding and Architecture Design
- API Development for communication between the frontend and backend components of the platform, ensuring smooth interactions.
- *Server Infrastructure and Hosting:* Funding for scalable, reliable server infrastructure is essential to host the platform, store data, and facilitate seamless user experiences. This investment ensures scalability, reliability, and optimal performance.
- *Cloud Hosting Services:* Subscription fees for cloud service providers like Amazon Web Services (AWS) or Microsoft Azure to deploy and manage server instances, databases, and storage resources.
- *Infrastructure Maintenance:* Costs for ongoing maintenance, updates, and monitoring of server infrastructure to ensure optimal performance and security.
- *Database Setup and Maintenance* is crucial for storing and managing user data, progress records, and content efficiently and securely. This involves the Initial setup and configuration of database systems such as PostgreSQL or MongoDB, including creating tables, defining schemas, and configuring access controls. Regular maintenance tasks such as database backups, updates, performance tuning, and optimization to enhance database efficiency and reliability.

Implementation of security measures like encryption, access controls, and data masking to protect sensitive information stored in the databases.

Total Backend Development Budget: $250,000

c. **Generative AI Integration:** Integrating generative AI into the platform adds a layer of intelligence for personalized content generation, creating a dynamic and adaptive learning environment. To leverage advanced AI capabilities, licensing fees are incurred to access proprietary or third-party AI technologies. This investment ensures compliance with licensing agreements and provides access to cutting-edge AI resources. Amount: $40,000

d. **Gamified Learning Analytics Module:** The gamified learning analytics module is crucial for analyzing user behaviour, and learning patterns, and providing valuable insights to enhance the educational experience. Investment in analytics tools and software is necessary to collect, process, and visualize data. This budget ensures the availability of tools that support effective analysis, providing valuable insights for educators and learners. Amount: $60,000

Total Development Costs ~ $450,000

5.1.2. Testing Costs: Unit Testing is vital for identifying and rectifying software defects at the component level, ensuring platform reliability. Skilled QA engineers, supported by necessary tools and licenses, conduct rigorous testing to resolve bugs before deployment. Integration testing ensures seamless interaction between platform modules, while additional resources simulate real-world scenarios for comprehensive performance assessment. Access to testing tools and licenses is crucial for effective testing. This budget category ensures that the testing team has the necessary resources to conduct thorough assessments.

Total Testing Costs: $150,000

5.1.3. Deployment Costs:

- **Beta Release:** This prepares the platform for initial testing by a limited audience. It involves allocating funds for marketing to attract beta users and gather early feedback as well as infrastructure costs to handle increased traffic as user base expands. Amount: $80,000

- **Optimization**: Focuses on enhancing the platform's performance based on user feedback and usage patterns. It involved Performance Analysis Tools for analyzing platform performance and identifying bottlenecks and areas for improvement. Amount: $15,000

Total Deployment Costs ~ $100,000

5.1.4. Marketing Costs: The launch marketing phase is crucial for creating awareness, attracting users, and establishing a strong market presence. It involves funding for advertising, promotional changes, public relations and media outreach efforts to establish positive relations with media. Amount: $75, 000

5.1.5. Maintenance Costs: The continuous improvement phase involves regular updates and enhancements to meet evolving user needs. Ongoing maintenance is essential for ensuring the platform's stability and responsiveness to user needs. Regular updates and feature enhancements, focus on integrating user feedback to adapt to evolving educational requirements. Additionally, allocating funds for technical support and bug fixes ensures timely issue resolution, contributing to a reliable user experience.

Total Maintenance Costs: $130,000

Total Development, Deployment, Marketing, and Maintenance Costs = $670,000 + $75,000 + $130,000 = $875,000

5.2. Resource Costing

5.2.1. Human Resources Costs: Different teams form the backbone of the project, translating the vision into a functional platform. Their skills and collaboration are essential for creating a user-friendly and technologically advanced educational gamification solution.

- *Lead Develop(1)r:* Provides technical leadership, ensures project alignment, and coordinates development efforts. Responsible for overseeing the entire development process. Salary: $120,000/year.
- *Software Engineers(Backend – 4, FrontEnd – 2, UI-UX designers - 2):* Responsible for coding, testing, and maintaining different components of the platform. Work in parallel to expedite development. Salary: $90,000/year each.
- *AI Specialist(1):* Integrates generative AI into the platform, ensuring personalized content generation aligns with educational objectives. Salary: $150,000/year.
- *Gamified Learning Analytics Team* (*Analytics Developers - 2):* Design and implement learning analytics modules, providing insights into user behavior and learning patterns. Essential for data-driven education. Salary: $100,000/year each.
- *Testing Team(2):* QA engineers ensure the platform's quality by conducting rigorous testing, and identifying and rectifying bugs before deployment. Salary: $80,000 per year (each)
- *Deployment and Optimization Team (Deployment Specialis/ Devops Engineerst)(2):* Manages platform release, ensuring smooth transitions and scalability. Salary: $100,000/year each.
- *Marketing and Support Team(Manager – 1, Team – 1):* Marketing Manager oversees promotional activities, creates awareness, and attracts users to the platform. Salary: $130,000/year. Marketing team member salary: 60,000/year
- *System Administrator(1):* Responsible for environment setup, including configuring and maintaining hardware, software, networks, and servers. They ensure the smooth operation of IT infrastructure, implement security measures, troubleshoot technical issues, and provide technical support to users. Additionally, they may be involved in system backups, disaster recovery

planning, and ensuring compliance with IT policies and regulations. Salary: $80,000/year

- *Customer Support Representatives(2):* Handle user queries promptly, contributing to a positive user experience and brand image. Salary: $70,000/year.

Total Resource Costs = $1,980,000

Total Project Budget = Resource + Other Costs = $1,980,000+ $875,000 = $2,855,000

5.3. Contingency Budget: A contingency budget is crucial to mitigate risks and handle unforeseen expenses that may arise during the development and implementation of the Educational Gamification Platform. We propose allocating a contingency budget of **10% of the total project budget** for unexpected costs and uncertainties.

- *Risk Management:* To mitigate technology risks, efforts will focus on resolving integration challenges related to generative AI and gamified learning analytics, handling licensing fees, and addressing potential technology glitches. Market risks will be managed by adapting to unforeseen demands and market changes, while adjusting marketing strategies accordingly. Regulatory risks will be mitigated by ensuring compliance with legal and regulatory requirements to avoid any budget implications.
- *Scope Changes:* The contingency budget will account for any requested additional features or modifications by stakeholders during development, ensuring flexibility without impacting the project timeline. Additionally, unexpected scalability needs arising from increased user demand or expanded functionalities can also be addressed with the contingency budget.
- *Human Resources:* Contingency budget addresses unexpected attrition or extended leaves among key team members, covering recruitment and potential overtime expenses. Additionally, it will support any required additional training for the team due to unforeseen technological advancements or changes, ensuring readiness for project demands.
- *External Dependency failures:* Unforeseen issues with external service providers, such as marketing agencies or training services, may occur. The contingency budget provides a buffer to address any disruptions caused by external dependencies.

- *Market Response:* The contingency budget enables swift adjustments based on early user feedback, facilitating rapid iterations and improvements in response to real-time user responses. This budget is calculated as 10% of the total project budget ($2,855,000), providing flexibility to address unforeseen needs and ensure project success.

5.4. Total Budget Including Contingency:

The adjusted project budget, considering the contingency, is $2,855,000+10% of $2,855,000 = $3,140,500.

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