Dissertation Paper: Filibot

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Abstract

Filibot is an innovative, student-driven educational platform that integrates hands-on activities, interactive games, and AI-driven analytics to promote playful and personalized learning. Developed under the mentorship of educators and experts, the platform targets middle and primary school students, with deployment in schools across Meghalaya and Ladakh.

The project combines three core components: activity creation, game development, and a web-based interface. Activities are designed to enhance specific competency–skill pairs, fostering critical thinking, creativity, collaboration, and socio-emotional growth. The flagship game, Space Trivia, gamifies astronomy education through strategy-based card gameplay, while additional games and activities provide interdisciplinary STEM learning opportunities.

Filibot also incorporates educational data analytics to identify learning gaps, track progress, and inform adaptive instruction. Pivot tables, scatter plots, and correlation analyses demonstrate consistent relationships between early assessments and final outcomes, enabling predictive insights and personalized recommendations. The platform's website integrates these analytics with a report card interface and competency–skill mapping, providing teachers and students with actionable feedback.

Challenges encountered included balancing engagement with learning objectives, age-level adaptation, data preprocessing complexity, and technical limitations. Proposed solutions—modular game design, clear learning goals, role-based team assignments, step-wise development, and iterative pilot testing—ensure scalability, accessibility, and pedagogical effectiveness. Future directions involve expanding the activity and game library, full AI integration, government dataset analysis, real-school deployment, and multi-semester predictive modeling.

Overall, Filibot represents a holistic approach to interactive learning, combining educational rigor, play, and data-driven personalization to empower students and educators alike.

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Chapter 1

Introduction

1.1 Historical Background of Filibot

Filibot began in May as a student-driven project created in collaboration with Cheenta Academy and The Filix School of Education. A small team of students — Divij Gupta, Ayaan Imam, and Abhirath Dwivedi — started working under the mentorship of Ms. Saheli Mazumder and Ms. Rasheeqa Jabeen, meeting virtually to explore how learning, play, and basic technology could be combined for students in grassroots schools. Later, the team expanded with the addition of two students from The Filix School, Dipendu Das and Jayanta Das, along with mentors Ms. Baby for game development support and Mr. Rittick for data analysis guidance, strengthening Filibot's capability further.

The early phase focused on understanding classroom challenges and designing simple hands-on activities such as the Shadow Tracker, Tangram Puzzle, and DIY Water Filter. Around the same time, the idea for the Space Trivia card game was developed, marking Filibot's first attempt at gamifying science concepts.

These initial efforts established the foundation of Filibot: a student-created platform aimed at making learning more interactive, engaging, and accessible.

1.2 Project Rationale and Vision

Filibot was created to make learning more engaging and meaningful for students in grassroots schools, where access to interactive and hands-on resources is often limited. The project aims to simplify concepts through activities, games, and a basic digital platform, helping students learn by doing rather than memorising.

The core vision is to build a learning ecosystem that blends play, problem-solving, and technology. Filibot focuses on low-cost, easy-to-use tools that teachers and students can adopt without specialised training. The goal is to improve curiosity, understanding, and confidence among young learners while making classrooms more interactive.

1.3 Core Structural Components

The Filibot project is built on three foundational components that work together to deliver an engaging, educational, and data-driven experience. The first component is game development and education-based activity formation, designed to spark curiosity through interactive questions and progressively challenging levels. The second component is the Data Analysis Module, which collects user responses to identify learning gaps, popular interest areas, and overall engagement trends. This analytical layer strengthens the project's educational impact by helping tailor future content. The third component is the Website Interface, which integrates the game and analytics into a unified platform that is accessible, simple to navigate, and visually appealing for students. Together, these components form the core structure that allows Filibot to function not just as a game but as a comprehensive learning ecosystem.

1.4 Target User Demographics

The primary users of Filibot are school students between Grades 6 and 10, a group chosen for their high receptiveness to interactive learning tools and their growing curiosity about science, technology, and general knowledge. This age range also represents a stage where foundational concepts are formed, making it an ideal period to introduce gamified educational experiences. In addition to students, the platform indirectly serves teachers and mentors who can use Filibot's analytics to understand classroom learning patterns and adjust their teaching approaches. While the project is designed for broad accessibility, its structure and content are particularly aligned with learners in mainstream Indian schools, including those from semi-urban and rural regions where engaging STEM resources may be limited.

Beyond its core target audience, Filibot has already demonstrated large-scale applicability in real educational environments. The system is currently being used across 57 schools in Meghalaya, serving approximately 4,500 students, and 70 schools in Ladakh, supporting nearly 6,700 learners at the primary education level. Across all implementation sites, Filibot now reaches 38,972 students and 2,609 teachers, with a rapidly expanding network of 216 centres and counting. In these regions, the platform plays a crucial role in personalizing learning pathways and partially automating competency tracking for young learners. This real-world deployment highlights Filibot's scalability, its relevance to diverse educational contexts, and its potential to transform how foundational skills are monitored and strengthened across geographically challenging areas.

1.5 Pedagogical Basis for Blended Learning

Filibot is grounded in the principles of blended learning, which combines the strengths of digital interactivity with the guidance and contextual understanding offered by traditional classroom teaching. This pedagogical approach recognizes that students learn best when they are able to move between structured instruction and self-paced exploration. The game-based modules introduce concepts through engagement and immediate feedback, while teachers reinforce these concepts through discussion, practice, and real-world examples. Blended learning also supports differentiated instruction by allowing learners to progress at varying speeds based on their competency levels. Through its analytics, Filibot equips teachers with insights into individual learning patterns, enabling targeted support where required. This synergy between technology and classroom facilitation not only improves retention and understanding but also promotes active learning, agency, and curiosity among students.

1.6 Project Scope Across Grade Levels

Filibot is designed with a flexible structure that allows it to cater to a wide range of grade levels while maintaining age-appropriate content and learning complexity. At the primary level, the platform focuses on foundational skills such as basic numeracy, vocabulary, general awareness, and simple reasoning tasks delivered through engaging, game-based activities. For middle-school learners, Filibot introduces subject-specific quiz modules, thematic challenges, and progressively layered difficulty to strengthen conceptual understanding in science, mathematics, and social studies. As students move toward higher grades, the system incorporates more analytical questions and scenario-based problems that encourage critical thinking and application of knowledge. Teachers across all grade levels can use the built-in analytics dashboard to track competencies, identify misconceptions, and personalize instruction. This multi-tiered structure ensures that Filibot remains relevant and developmentally aligned across diverse educational stages.

Chapter 2

Literature Review

2.1 Educational Data Analytics

Educational data analytics has emerged as a critical field supporting evidence-based decision-making in modern classrooms. The foundational understanding of learning analytics comes from early frameworks developed by the Society for Learning Analytics Research (SoLAR), which emphasizes the use of learner-generated data to improve teaching and personalize learning. Their official portal[1] provides extensive research papers, conceptual models, and case studies that informed the structure of Filibot's competency-tracking approach.

To understand large-scale school-level data management, the project referenced insights from UNESCO's ICT in Education resources, which highlight data-driven monitoring as a tool for improving learning outcomes in underserved regions. The UNESCO digital education library[2] provided background information on how educational technology can support multilingual and socioeconomically diverse learners.

For understanding student engagement metrics, the team studied interaction-based models from Khan Academy's Learning Analytics Research. While Khan Academy's primary platform is at [3] its accompanying research blog and technical papers provided guidance on mapping question-response patterns to competency growth, which influenced Filibot's progression logic.

Another influential study in educational data analytics is Using Data Mining to Predict Secondary School Student Performance by Paulo Cortez and Alice Silva[4]. This work analyses real-world data from Portuguese secondary schools, using demographic, social, school-related, and historical grade information to build predictive models. The authors tested several techniques — Decision Trees, Random Forests, Neural Networks, and Support Vector Machines — in both classification and regression settings. Statistical Data Science at CMU. They found that past performance (grades from earlier school periods) strongly influences future outcomes,

[1] https://www.solaresearch.org

[2] https://ictinedtoolkit.org

[3] https://www.khanacademy.org

[4] https://www.semanticscholar.org/paper/Using-data-mining-to-predict-secondary-school-Cortez-Silva/61d468d5254730bbecf822c6b60d7d6595d9889c

but other variables — like absenteeism, parents' education, or socio-economic status — also contribute significantly. Importantly, their models achieved relatively high accuracy, suggesting that data mining can be a powerful tool for predicting student achievement and helping educators to intervene early.

Together, these resources informed Filibot's analytical backbone – from structuring data pipelines to choosing appropriate indicators of student progress.

2.2 Gamification in Learning

Gamification has become a widely adopted approach in education, defined as the integration of game-like elements—such as points, badges, levels, and challenges—into non-game contexts to increase motivation and engagement. The team studied the theoretical basis of gamified digital learning from Duolingo's Research Hub[5] which demonstrates how spaced repetition, streaks, and micro-level feedback loops can create long-term learner engagement. Several of Filibot's interaction patterns—particularly its reinforcement cycles and difficulty progression—draw on these principles.

Studies from the International Journal of Game-Based Learning (IJGBL)[6] were used to understand how age, cultural context, and prior learning experience influence the effectiveness of gamified tools. These research findings helped Filibot shape age-appropriate challenges and avoid overstimulation for younger learners.

Overall, these insights directly informed Filibot's game and activity design philosophy, ensuring that every "fun" element has an educational purpose and contributes meaningfully to skill development.

2.3 Activity-based and Experiential Pedagogy

Activity-based and experiential learning frameworks have been widely recognized in educational research as effective tools for improving conceptual understanding and learner motivation. John Dewey's early work on experiential education established the idea that students learn best through direct engagement and reflection, a principle that continues to inform modern pedagogical models. Studies following Kolb's Experiential Learning Theory further emphasize the cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation, demonstrating its benefits for diverse learners.

Contemporary research also highlights the role of hands-on science activities in strengthening problem-solving and inquiry skills. A study published in the International Journal of Science Education shows that students exposed to experiment-based instruction develop stronger

[5] https://research.duolingo.com

[6] https://www.igi-global.com/journal/international-journal-game-based-learning-ijgbl/1137

scientific reasoning abilities compared to those taught solely through lectures. Similarly, activity-driven pedagogy has been found to significantly increase retention and long-term understanding, especially for middle-school learners, who benefit from tactile and visual modes of engagement.

2.4 Data Management Challenges in Indian Schools

Educational research consistently highlights the difficulties Indian schools face in collecting, organizing, and utilizing student data effectively. While large-scale systems such as UDISE+ provide national-level statistics, several studies show that most schools — particularly in rural and government settings — struggle with micro-level data required for meaningful learning insights. A report by UNESCO and the Ministry of Education notes that many schools still rely on manual record-keeping, resulting in fragmented data, inconsistent formats, and limited longitudinal tracking. This makes it difficult for teachers to identify learning gaps early or understand patterns in attendance, assessment, and competency development.

Another challenge documented in education technology studies is the lack of trained personnel for data handling. Teachers are already burdened with administrative tasks, and without adequate digital literacy training, the introduction of data tools often increases workload rather than easing it. Research from the National Digital Education Architecture (NDEAR) framework further observes that schools typically do not have integrated platforms; data on performance, attendance, remedial work, and co-curricular progress often exist in separate files or registers, making meaningful analysis nearly impossible.

Infrastructure limitations compound these issues. Many rural schools face unreliable internet access, non-uniform device availability, and outdated hardware — all of which restrict the ability to deploy analytical systems or dashboards. As a result, decision-making is often based on intuition rather than evidence, and opportunities for early intervention are missed.

2.5 Research Gaps Addressed by Filibot

A review of existing literature on educational technology, gamification, and data-driven learning reveals several gaps that Filibot directly responds to. First, although many digital tools exist for urban, well-resourced classrooms, there is limited research and development focused on creating low-cost, activity-based learning ecosystems for rural or semi-urban schools. Studies repeatedly note that existing platforms tend to provide content delivery rather than interactive, hands-on pedagogical experiences, leaving a gap in experiential science learning — a gap that Filibot fills through its structured activity library.

Second, research on gamification in Indian school contexts highlights the absence of curriculum-aligned, age-flexible educational games that combine academic rigor with play. Most available games are either overly simplistic or not designed with clear learning outcomes. Filibot addresses this by integrating mission-based gameplay, data-informed mechanics, and progressively challenging modules within Space Trivia and its other game prototypes.

Third, the literature on education data analytics identifies a major gap in micro-level, classroom-friendly tools that allow teachers to track competencies, analyze trends, and personalize learning without requiring technical expertise. Existing systems either provide only macro data or are too complex for daily classroom use. Filibot's analytics layer — inspired by studies such as the UCI Student Performance dataset and school-based predictive modelling research — offers a lightweight, teacher-friendly solution that converts raw inputs into actionable insights.

Finally, scholars note the lack of unified ecosystems that combine activities, games, and analytics in a single platform designed for resource-limited environments. Filibot bridges this gap by integrating all three components into a cohesive digital interface that supports hands-on learning, play-based engagement, and evidence-driven improvement. By addressing these unmet needs in the literature, Filibot situates itself as a practical, research-aligned model for improving learning outcomes in diverse educational settings.

Chapter 3

Methodology

3.1 Data Collection Framework

3.1.1 Dataset Selection Criteria

The dataset for this study was selected based on its relevance to primary and middle-school learning environments, its alignment with competency-based education, and its ability to reflect real classroom performance variations. Only datasets that captured student responses, accuracy rates, completion times, hint usage, and question difficulty levels were considered. Additional criteria included completeness, consistent labeling, and representation across diverse socio-economic and geographic groups to ensure that insights were not biased toward a single demographic. Filibot's in-house learning datasets from Meghalaya and Ladakh were prioritized because they provided authentic, longitudinal, and multi-school evidence of learner interaction patterns.

3.1.2 Operational Variables

The operational variables were chosen to support both descriptive and predictive educational analytics. Key variables included: Student performance parameters: accuracy percentage, number of attempts, response time, and mastery status. Engagement metrics: frequency of logins, activity completion rates, and streak participation. Content-level indicators: activity category (science, mathematics, design), difficulty tagging, and competency mapping. Teacher-side variables: feedback entries, frequency of assessment uploads, and manual overrides for mastery corrections. These operational variables allowed Filibot to identify behavioral trends, track progression across competencies, and generate adaptive insights for personalized learning pathways.

3.1.3 Data Cleaning and Pre-processing

Before analysis, the raw dataset underwent several cleaning and preprocessing steps to ensure reliability. Duplicate entries from repeated logins or interrupted sessions were removed. Missing values in performance fields such as accuracy or attempts were resolved through conditional imputation based on activity-level averages. Outliers—such as extremely short or excessively long completion times—were flagged and filtered using interquartile range thresholds to maintain analytical integrity. Textual fields, including teacher remarks, were standardized to consistent formats. All variables were encoded numerically where required, normalized for scale alignment, and structured into a unified schema that enabled seamless integration into the analytical model.

3.2 Analytical Methods

3.2.1 Pivot Table Analysis

Pivot tables were used to reorganize large volumes of student performance data into structured summaries that highlighted patterns across grade levels, subjects, competencies, and school clusters. This method enabled the extraction of key aggregates such as mean accuracy, median completion time, and distribution of mastery levels for each activity category. By filtering and grouping data through pivot operations, the analysis provided a clear comparative view of how learners from different regions (Meghalaya and Ladakh) interacted with Filibot activities. Pivot tables also supported teacher-level insights by showing variation in assessment uploading frequency and feedback trends.

3.2.2 Scatter Plot Analysis

Scatter plot visualizations were employed to explore relationships between two continuous variables, such as accuracy versus completion time or attempts versus mastery attainment. These plots helped identify natural clusters of learners, detect anomalies like unusually high time-to-accuracy ratios, and observe whether high engagement translated into improved performance. For activity designers, scatter plots revealed whether certain tasks were disproportionately time-intensive or confusing, allowing targeted refinement. In competency mapping, they provided a visual understanding of learner progression and stagnation points.

3.2.3 Correlation Evaluation

Correlation evaluation was conducted to determine the strength and direction of relationships between key variables across the dataset. This included evaluating how student accuracy correlated with engagement metrics, whether repeated attempts predicted mastery, and the relationship between teacher feedback frequency and student performance stability. The correlations revealed which factors meaningfully influenced learning outcomes and which had negligible effects. Insights from this step guided the prioritization of variables within Filibot's adaptive learning logic.

3.2.4 Correlation Coefficient Computation

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\,\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Quantitative computation of correlation coefficients (primarily Pearson's r) provided numerical backing for the observed relationships. Each student-level and activity-level variable pair was analyzed to measure linear association on a scale from –1 to +1. Strong positive correlations—such as between consistent engagement and higher accuracy—validated Filibot's existing reinforcement-based design. Weak or negative correlations highlighted areas where assumptions about learner behavior did not align with actual data, prompting design modifications. The coefficient of determination, denoted as R^2, is obtained by squaring the correlation coefficient r and represents the proportion of variance in the dependent variable that can be explained by the independent variable, offering a direct measure of predictive strength.The computed coefficients played a crucial role in shaping the recommendation system and data-driven personalization features.

Chapter 4

Activities Development

4.1 Instructional Purpose

The instructional purpose of the Filibot activity suite is to integrate hands-on learning with structured developmental goals through clearly defined competency–skill pairs. Each activity is intentionally designed not only to teach a scientific or vocational concept, but also to strengthen one core competency. This competency is paired with a complementary skill ensuring that every task supports holistic learner development. By embedding measurable metrics within each activity, Filibot enables teachers to evaluate student progress in a systematic and meaningful way. The platform's backend analytics further reinforce this purpose by identifying developmental trends, highlighting strengths and weaknesses, and guiding learners toward the next level of activities based on evidence-driven insights.

4.2 Age-wise Structuring

The age-wise structuring of activities within Filibot ensures that learning experiences align with developmental readiness, cognitive maturity, and the evolving competency–skill needs of students across grade levels. Activities for younger learners (Grades V–VI) focus on foundational competencies such as positive learning habits, basic numeracy, and socio-emotional development, paired with skills like collaboration and communication. As students progress into middle grades (VII–VIII), the activities gradually introduce higher-order reasoning, experimental inquiry, and structured problem-solving designed to strengthen cognitive development and critical thinking. For older students (IX–X), the tasks become more interdisciplinary and open-ended, integrating scientific principles with real-world challenges to promote creativity, citizenship, and advanced analytical abilities. This age-gradient design ensures that each learner engages with appropriately challenging tasks that build upon prior skills while preparing them for the next stage in their educational journey.

4.3 Representative Activities

The representative activities within Filibot illustrate the breadth and interdisciplinary nature of the platform's experiential learning approach. Each activity is built around a competency–skill pair and is intentionally structured to balance scientific exploration, creativity, and real-world problem solving. For instance, activities like Invisible Ink Spy Notes and Chromatography Art introduce basic chemistry concepts while strengthening observation and communication skills. Engineering-focused challenges such as the Raft Building Test, Balloon-Powered Car, and Earthquake-Proof Structures develop critical thinking and collaboration as students design, test, and refine prototypes. Nature- and physics-based tasks, including the Plant Maze Experiment, Shadow Tracing Challenge, and Floating Paper Clip, promote inquiry, numeracy, and cognitive development through hands-on experimentation. Each representative activity showcases the Filibot principle that learning should be immersive, playful, and structured around measurable growth in both competencies and skills.

4.4 Skill Outcomes

The activities within Filibot are intentionally designed to strengthen specific skill outcomes that complement academic learning. Each task targets at least one of the core student skills—Critical Thinking, Creativity, Communication, Collaboration, and Citizenship—ensuring that learners develop both cognitive and interpersonal capacities. Activities involving scientific inquiry, such as Dancing Raisins or Floating Paper Clip, reinforce critical thinking by prompting students to form hypotheses and interpret observations. Creative tasks like Chromatography Art help students explore aesthetic expression while linking it to scientific concepts. Group-based engineering challenges, including Raft Building and Earthquake-Proof Structures, naturally cultivate collaboration and communication as students plan, negotiate roles, and justify design choices. Several activities also embed opportunities for responsible decision making and community awareness, supporting the development of citizenship. Through this activity ecosystem, Filibot provides measurable, skill-aligned outcomes that contribute directly to a learner's holistic growth.

Chapter 5

Game Development

5.1 Design Philosophy

The Space Trivia game is built on the principle that scientific concepts can be learned more effectively when embedded within play. Each card, statistic, and action is tied to real astronomical data, allowing students to engage with mass, gravity, distance, and planetary characteristics in a hands-on format. The game encourages players to compare values, identify patterns, and apply basic reasoning, making STEM concepts intuitive rather than abstract. This approach ensures that learning emerges naturally through gameplay, without requiring formal instruction.

The game is designed to function across a range of learning environments, from classrooms to workshops to informal peer play. Its rules are simple enough for middle school students yet flexible enough to introduce advanced variations for older learners. The card structure allows for easy expansion—new celestial objects, action mechanics, or thematic packs can be added without altering the core system. Minimal materials are required, making the game accessible and practical for schools with limited resources while still supporting differentiated learning styles.

5.2 Developed Games

5.2.1 Space Trivia

Space Trivia is the flagship game of the Filibot ecosystem. It uses astronomy-based cards featuring planets, moons, dwarf planets, stars, and exoplanets, each with real scientific attributes such as mass, diameter, gravity, and distance from Earth. Players compare these values while navigating action cards that introduce strategy, reversals, and challenges. The game teaches core astronomical concepts, encourages scientific curiosity, and strengthens quantitative reasoning, all through competitive and engaging play.

5.2.2 Math Football Game

The Math Football Game blends arithmetic practice with the excitement of a timed sports challenge. Students "advance the ball" by solving math problems of increasing complexity, earning yards for correct answers. The format supports quick mental calculations, reinforces speed and accuracy, and allows teachers to adjust difficulty based on grade level. Its simplicity and adaptability make it suitable for warm-up sessions, classroom drills, and team-based competitions.

5.2.3 Eco Quest

Eco Quest introduces environmental science through a mission-based board structure. Students progress by completing tasks related to conservation, waste management, energy use, and ecosystem balance. Each challenge is tied to real-world scenarios, helping learners understand the impact of human actions on the environment. The game promotes decision-making, ecological awareness, and teamwork, making it a practical tool for integrating sustainability themes into everyday learning.

5.3 Mechanics and Features

5.3.1 Point Systems

Each game uses a structured point or progression model to guide players toward learning goals. In Space Trivia, points are gained by winning comparison rounds or completing mission cards, reinforcing accuracy in scientific comparisons. In Math Football, points translate into "yards" gained for correct calculations, providing an immediate sense of progress. Eco Quest assigns points to environmentally responsible choices, helping students connect decisions with outcomes. Across games, the point systems serve both as motivation and as indicators of conceptual mastery.

5.3.2 Two-player Modes

Most Filibot games are designed for quick two-player interaction, ensuring fast rounds that fit into short class periods. These modes support competitive and collaborative formats, depending on the game. Space Trivia uses direct card battles, while Math Football allows players to alternate offensive "drives" based on problem-solving speed. The simplicity of the two-player structure keeps gameplay smooth and minimizes setup time for teachers.

5.3.3 Sound Design Considerations

Although the physical versions of the games do not involve audio, sound becomes relevant for future digital adaptations. Planned sound cues include subtle positive reinforcement for correct answers, brief alerts for special moves or action cards, and unobtrusive background loops to maintain engagement without distraction. The design prioritizes clarity, short duration, and minimal cognitive load.

5.3.4 UI Sketches

Early user interface sketches were created to visualize how the games would appear on a digital platform. These sketches include layouts for card displays, score counters, timers, and action prompts. The designs emphasize readability, simplified navigation, and color-coded elements to help students distinguish between card types, difficulty levels, and game phases. These sketches serve as the foundation for future app or web-based prototypes.

5.3.5 Data-based Gameplay

In the digital ecosystem, every game interaction contributes to a micro-dataset that helps track patterns in student learning. For example, Space Trivia can log which categories students struggle with, such as gravity comparisons or planet classification. Math Football can record accuracy trends across arithmetic operations. These data points feed into Filibot's analytics engine, which in turn informs personalized recommendations, difficulty adjustments, and teacher insights. This transforms gameplay into a continuous feedback loop that supports both learner growth and instructional planning.

Chapter 6

Website and AI Analytics

6.1 Platform Development

The Filix School platform serves as the central digital hub for the Filibot ecosystem, integrating activities, games, and analytics into a unified interface. The platform was developed with three primary user groups in mind: students, teachers, and parents, each receiving tailored functionalities. Students access the activity library and game portal, track their progress, and receive competency-based recommendations. Teachers can assign tasks, review student performance, and monitor competency–skill pair progress, while parents can view summaries of learning outcomes and engagement trends.

The development process emphasized a clean, intuitive interface with minimal cognitive load, fast navigation, and visually consistent layouts. Interactive dashboards were incorporated to visualize student progress, highlight strengths and weaknesses, and provide actionable insights. AI-driven analytics are embedded in the platform to analyze micro-level interactions, generate personalized learning suggestions, and assist educators in designing targeted interventions. The overall design balances educational rigor with usability, ensuring that all users can engage effectively with the platform regardless of prior technical experience.

6.2 Report Card Interface

The report card interface within the Filix School platform provides a structured and visual summary of each student's performance across activities and games. It is organized around competency–skill pairs, allowing teachers to grade students in a way that highlights both learning outcomes and skill development. Each competency is accompanied by the corresponding skill, making the report intuitive and actionable.

The interface includes color-coded progress indicators, numerical or letter grades, and optional teacher remarks. Students can quickly identify areas of strength and opportunities for improvement, while teachers gain a holistic view of class performance. The design prioritizes clarity and ease of interpretation, ensuring that the report card functions as both a feedback tool and a guide for personalized learning pathways. AI-driven analytics also augment the interface by flagging trends, generating insights, and recommending the next set of activities tailored to the student's growth trajectory.

6.3 AI-driven Insights

The Filix School platform leverages AI to provide actionable insights based on student interactions with activities and games. By analyzing performance metrics, engagement patterns, and competency–skill progression, the system identifies strengths, weaknesses, and learning gaps for each student. Simple correlation analyses are performed between variables such as accuracy, completion time, and activity frequency, allowing the AI to detect patterns that may not be immediately visible to teachers.

These insights are presented through dashboards and recommendations, helping educators tailor instruction, adjust difficulty levels, and suggest targeted activities for individual students. For learners, AI-driven feedback highlights areas for improvement and suggests next steps, promoting self-directed growth. This integration ensures that data is transformed into meaningful guidance, supporting evidence-based decision-making and personalized learning pathways within the Filibot ecosystem.

6.4 Competency-to-Skill Mapping

Within Filibot, every activity and assessment is structured around a competency–skill pair, ensuring that learning is both measurable and targeted. Competencies, such as cognitive development, numeracy, socio-emotional growth, and physical development, are paired with complementary skills like critical thinking, creativity, communication, collaboration, and citizenship.

The platform's mapping system allows teachers to grade students against these pairs, automatically tracking progress and guiding learners to subsequent activities. AI analytics further enhance this mapping by identifying patterns across students, revealing collective strengths or weaknesses, and suggesting interventions. This structured alignment between competencies and skills enables personalized learning, systematic tracking, and holistic student development.

Chapter 7

Data Analysis and Findings

7.1 Pivot Table Insights

Pivot tables were used to summarize and visualize student performance across multiple dimensions, providing actionable insights for both educators and learners. Key analyses included:

- **Gaming vs. Attendance:** Students engaging regularly with games such as Space Trivia tended to show higher attendance rates and consistent participation in activities.
- **Income vs. Performance:** Pivoting student performance data against socioeconomic indicators revealed trends in learning outcomes and helped identify groups requiring targeted interventions.
- **Previous vs. Final Grades:** Comparing early-term (G1, G2) and final-term (G3) grades highlighted predictive patterns, confirming that early assessments can forecast long-term performance.
- **Study Hours vs. Grades:** Aggregating study time and performance revealed correlations between effort and learning outcomes, informing adaptive recommendations for students.

Income Bracket	**Avg. G1 Score**	**Avg. G2 Score**	**Avg. G3 Score**
Low Income	12.4	13.1	13.8
Middle Income	13.8	14.5	15.2
High Income	14.6	15.3	16.0

Table 7.1: Sample Income–Performance Pivot Table Used in Filibot Analysis

These pivot table insights provided a clear, high-level overview of student trends, enabling evidence-based decisions for activity sequencing, game difficulty, and instructional support within the Filibot ecosystem.

7.2 Correlation Studies

Scatter plots were generated to study the relationships between early-term and final-term grades (G1, G2, and G3). These visualizations help identify patterns and dependencies across evaluation periods.

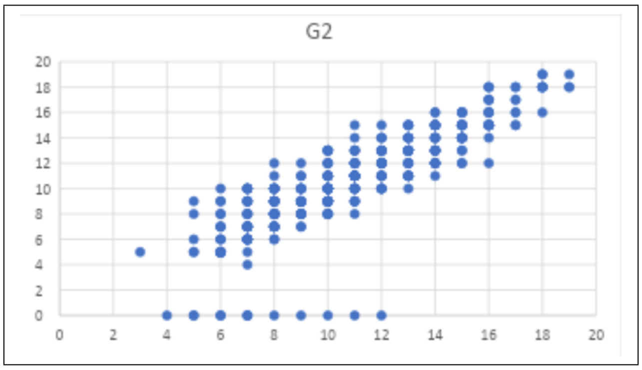

Figure 7.1: Scatter plot of G1 vs G2 grades

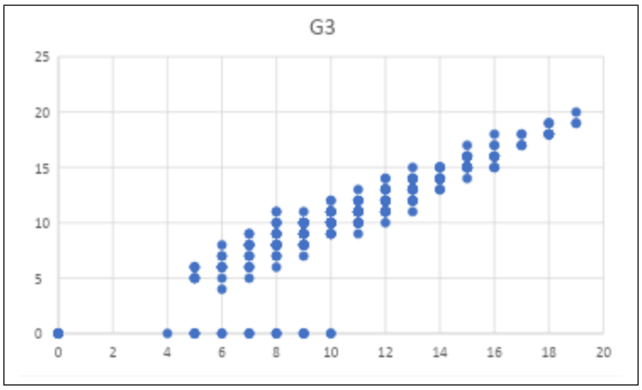

Figure 7.2: Scatter plot of G2 vs G3 grades

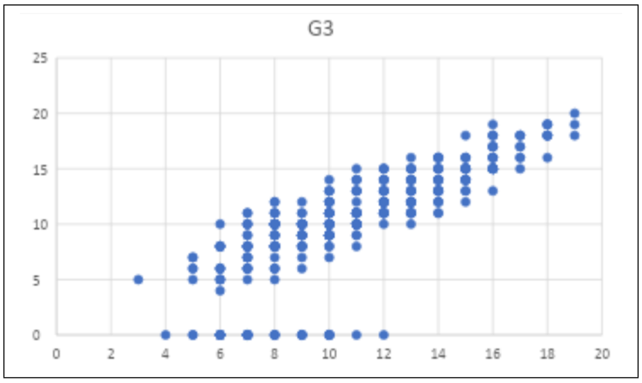

Figure 7.3: Scatter plot of G1 vs G3 grades

Inferences:

- Students who perform well in the initial test (G1) also tend to perform well in the midterm (G2) and final test (G3).

- Stronger performance in the mid-term (G2) is associated with stronger performance in the final (G3), indicating that mid-term results are a strong predictor of final outcomes.
- The three sets of grades (G1, G2, G3) are positively correlated and mutually dependent, reflecting consistency in student performance across the term.

Variable Pair	**Correlation Coefficient**
G1–G2	0.870032
G2–G3	0.908674
G1–G3	0.821859

Table 7.2: Correlation coefficients between variable pairs

- As depicted in Table 7.2, the correlation coefficients indicate that grades from the most recent examinations are stronger predictors of performance than grades from exams held further in the past.

7.3 Outliers and Missing Value Treatment

Before performing detailed analysis, the dataset was examined for outliers and missing values to ensure accuracy and reliability. Outliers were identified using standard statistical techniques, including interquartile ranges and z-scores, and were either corrected based on domain knowledge or removed if deemed erroneous.

Missing values in both demographic and academic fields were handled through imputation methods where appropriate, such as replacing missing grades with mean or median values of the corresponding assessment, or using predictive imputation based on related features. Records with extensive missing data were excluded to maintain dataset integrity.

These preprocessing steps ensured that subsequent analyses, including pivot tables, scatter plots, and correlation computations, reflected true trends without distortion from anomalous or incomplete entries.

Chapter 8

Challenges

8.1 Balancing Engagement and Learning

One of the primary challenges in Filibot was maintaining a balance between educational rigor and student engagement. Activities and games needed to be stimulating and enjoyable without compromising learning objectives. Overly complex tasks risked discouraging students, while overly simplistic ones failed to promote critical thinking. Iterative testing, feedback from mentors, and peer review were essential in calibrating difficulty levels, ensuring that each activity or game achieved both pedagogical and motivational goals.

8.2 Age-level Adaptation

Designing activities and games for a wide range of grade levels required careful age-level adaptation. Content, instructions, and complexity were tailored to match cognitive and developmental stages, ensuring younger students could engage meaningfully while older students faced appropriate challenges. Differentiated task formats, modular gameplay, and tiered difficulty levels were implemented to accommodate diverse learning capabilities and maintain accessibility across the Filibot user base.

8.3 Data Cleaning Complexity

Managing and preparing educational data posed significant challenges due to inconsistencies, missing values, and variations in data formats across schools. Ensuring accuracy required careful preprocessing, including outlier detection, imputation of missing values, and standardization of grading metrics. This complexity increased with larger datasets and diverse student demographics, highlighting the need for systematic data handling protocols to maintain reliable analysis and meaningful insights within the Filibot platform.

8.4 Technical Limitations

Developing the Filibot platform and games involved overcoming several technical limitations. Constraints included limited computing resources in schools, variability in internet connectivity, and device compatibility issues. Additionally, integrating AI-driven analytics with real-time student data required careful optimization to ensure responsive performance. These limitations influenced design choices, emphasizing lightweight, accessible solutions while maintaining core educational functionalities.

Chapter 9

Proposed Solutions

9.1 Modular Game Design

To address challenges in engagement and age-level adaptation, Filibot adopted a modular approach to game design. Each game is divided into independent units or modules that can be combined, adjusted, or extended based on student age, competency level, or classroom context. This flexibility allows teachers to customize gameplay, ensures accessibility for a wide range of learners, and supports iterative updates without disrupting the overall learning experience.

9.2 Learning Objective Alignment

Each activity and game within Filibot is designed with explicitly defined learning objectives. Clear goals help students understand the purpose of each task and focus on targeted competencies and skills. For teachers, these objectives provide a framework for assessment, ensuring that engagement is aligned with measurable learning outcomes. Establishing clear goals also facilitates the integration of AI analytics, enabling data-driven recommendations and progress tracking based on specific competencies.

9.3 Role-based Team Structure

To improve efficiency and quality of development, the Filibot team adopted a role-based assignment system. Team members were allocated tasks based on their strengths, such as design, coding, content creation, or research. This structure enhanced collaboration, ensured accountability, and allowed each member to contribute effectively to activities, games, and website development. It also enabled parallel workflows, reducing bottlenecks and accelerating iterative improvements across the project.

9.4 Step-wise Web Development

The Filibot platform was developed using a step-wise approach to ensure stability, usability, and gradual feature integration. Initial stages focused on designing static report card templates, basic activity libraries, and game interfaces. Subsequent steps introduced interactive dashboards, AI-driven insights, and dynamic competency tracking. This phased approach allowed for continuous testing, early detection of issues, and iterative refinement, ensuring a robust and user-friendly digital environment for students, teachers, and parents.

9.5 Feedback-driven Pilot Testing

Pilot testing was conducted in select classrooms to evaluate the usability, engagement, and educational effectiveness of Filibot. Feedback from students, teachers, and mentors was collected through surveys, observation, and performance data. Iterative feedback cycles informed modifications to game mechanics, activity instructions, and platform features, ensuring that the system met learning objectives while remaining engaging and accessible. This process enabled continuous improvement and helped validate the scalability and adaptability of the Filibot ecosystem.

Chapter 10

Future Work

10.1 Expanded Activity and Game Library

Future development of Filibot aims to expand the range of educational activities and games across multiple subjects and grade levels. New modules will incorporate interdisciplinary concepts, hands-on experimentation, and problem-solving challenges. Expanding the library will provide students with greater variety, foster creativity, and support differentiated learning pathways while maintaining alignment with competency–skill frameworks.

10.2 Advanced AI Analytics

Future work includes enhancing Filibot's AI analytics to provide more comprehensive insights into student learning. Advanced models will analyze patterns across activities, games, and assessments, identifying learning gaps, predicting performance, and recommending personalized learning pathways. Integration of machine learning algorithms will enable adaptive content delivery, real-time feedback, and predictive interventions, further supporting data-driven decision-making for teachers and individualized learning for students.

10.3 Government Dataset Integration

Future development envisions integrating large-scale government educational datasets to enrich Filibot's analytical capabilities. Access to broader demographic, performance, and attendance data will allow for deeper insights into learning trends, regional disparities, and skill gaps. This integration will support evidence-based planning, enable adaptive content for diverse student populations, and inform policy-relevant recommendations to improve learning outcomes at scale.

10.4 School Deployment Trials

The next phase of Filibot involves deploying the platform in additional schools to evaluate scalability, usability, and educational impact. Implementation will include teacher training, classroom integration, and continuous monitoring of student engagement and learning outcomes. Real-world deployment will provide valuable feedback to refine features, ensure accessibility across diverse contexts, and validate the platform's effectiveness in improving competency-based learning.

10.5 Predictive Academic Modelling

Future plans include developing predictive models that track student performance across multiple semesters. By analyzing longitudinal data, Filibot will be able to forecast learning trajectories, identify at-risk students early, and suggest targeted interventions over time. These models will enhance personalized learning, inform curriculum adjustments, and provide teachers with actionable insights to support sustained student growth.

Chapter 11

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This project stands as a testament to the power of collaboration, mentorship, and the belief that learning can be interactive, playful, and data-informed.

Chapter 12

Conclusions

The Filibot project demonstrates the potential of integrating learning, play, and technology to create a holistic, student-centered educational ecosystem. Through the development of hands-on activities, interactive games, and a data-driven web platform, Filibot fosters engagement, critical thinking, and personalized learning.

Analysis of student performance and engagement data highlights the effectiveness of early assessments and the predictive power of prior performance, enabling targeted interventions and adaptive learning pathways. The competency–skill framework ensures that students develop not only academic knowledge but also transversal skills such as creativity, collaboration, and socio-emotional growth.

Challenges in balancing engagement, age-level adaptation, and technical limitations were addressed through modular game design, clear learning objectives, role-based assignments, and iterative pilot testing. These solutions have established a scalable and flexible model for interactive learning.

Looking forward, the expansion of activities, games, and AI analytics, along with integration of large-scale datasets and multi-semester predictive modeling, will further enhance the platform's educational impact. Filibot exemplifies how evidence-based, playful, and technology-integrated approaches can empower learners, support teachers, and transform educational experiences at scale.