Gamified Coding Platforms for Dyslexic Learners: Enhancing Accessibility and Engagement Through Inclusive Design

SHAZIYA MUJAHID[1], SUMAIYA SULTANA[2]
[1, 2]5th Semester, Bachelor's of Computer Applications, BET Sadathunnisa Degree College Bengaluru, Karnataka, India

Abstract - Dyslexia presents significant challenges in text-heavy learning environments, particularly in computer programming where symbol recognition and syntax precision are critical. Traditional coding education often lacks the inclusive features necessary to support learners with dyslexia, resulting in reduced engagement and achievement gaps. This paper explores the development of a gamified coding platform designed specifically for dyslexic learners. The proposed system, CodeMaze, integrates dyslexia-friendly fonts, simplified visual interfaces, audio narration, and block-based programming to reduce cognitive load. Learners progress through puzzles and missions that gradually transition from visual block commands to textual code. An experimental study with secondary-level students demonstrates that CodeMaze increased engagement time by 30%, reduced syntax-related errors by 40%, and improved learner confidence compared to conventional block- based tools. Findings suggest that gamification combined with inclusive design principles significantly enhances coding education for dyslexic learners. Future directions include adaptive learning pathways, collaborative game mechanics, and mobile-first deployment to increase accessibility.

I. INTRODUCTION

Programming is increasingly recognized as a core literacy of the 21st century, providing students with problem-solving skills, logical reasoning, and opportunities for innovation. However, for learners with dyslexia—a neurodevelopmental lea rning disorder that affects reading fluency, spelling, and symbol recognition— programming presents unique challenges. Dyslexic learners often struggle with syntax-heavy languages such as Python, Java, or C++, where a single misplaced symbol may cause errors that are difficult to trace. These difficulties are compounded by traditional teaching approaches, which typically rely on text- heavy explanations, long code samples, and minimal interactive support. Globally, dyslexia affects between 5% and 10% of the population (Lyon et al., 2003), meaning millions of potential learners face systemic barriers in computer science education. Despite the widespread adoption of block- based programming environments like Scratch, Blockly, and Pocket Code, existing tools remain insufficient for dyslexic learners because they prioritize simplification of syntax but neglect accessibility-oriented design. For example, many interfaces still use standard fonts, dense text layouts, and minimal auditory support—features that can overload working memory and reduce learner confidence. Gamification has emerged as a promising approach to education, leveraging elements such as points, levels, narratives, and challenges to increase student engagement and motivation (Hamari et al., 2014). In the context of programming, gamified platforms such as Lightbot and CodeCombat demonstrate that learning logic and coding principles can be both interactive and enjoyable. However, very few of these systems are intentionally designed with dyslexia in mind. This creates an opportunity to design tools that combine the engagement benefits of gamification with the cognitive accessibility principles needed by dyslexic learners. The present study addresses this gap by introducing CodeMaze, a gamified coding platform tailored to dyslexic learners. The system integrates dyslexia-friendly fonts, minimal distractions, text-to-speech feedback, and scaffolded learning pathways that transition students from visual block commands to text- based code. By situating programming within an adventure- based game enviro nment, CodeMaze aims to reduce anxiety, build confidence, and improve learning outcomes for dyslexic learners. This research investigates the effectiveness of Code Maze through a comparative study against existing block- based platforms, with the goal of demonstrating how inclusive gamified tools can broaden participation in programming education.

II. LITERATURE SURVEY

- Dyslexia and Learning Challenges-

Dyslexia is a neurodevelopmental disorder affecting reading fluency, spelling, and symbol recognition, often accompanied by difficulties in working memory and rapid information processing. Learners with dyslexia may reverse letters or symbols, misread commands, or struggle to follow sequential instructions— issues that directly impact programming tasks, where syntax precision and logic sequencing are critical. Early identification and intervention are crucial to mitigate learning delays and build confidence, as dyslexic learners often experience frustration and lower self-esteem in traditional educational settings.

- Gamification in Education-

Gamification involves integrating game elements such as points, badges, levels, challenges, and narratives into non-game contexts to increase motivation, engagement, and learning outcomes. In educational contexts, gamified systems encourage learners to persist through challenges and provide immediate feedback on performance. Studies have shown that gamification improves cognitive engagement, reduces dropout rates, and fosters intrinsic motivation, making it a promising strategy for learners with cognitive or attention difficulties.

- Coding Education and Visual Programming-

Visual or block-based programming platforms like Scratch, Blockly, and Pocket Code simplify coding by replacing syntax-heavy text with drag-and-drop blocks. These tools help reduce cognitive load and syntax-related errors, which is especially beneficial for dyslexic learners. Similarly, gamified coding apps like Lightbot and CodeCombat combine problem-solving challenges with interactive storytelling, which increases learner engagement. However, despite these advancements, most existing platforms do not incorporate accessibility features explicitly designed for dyslexic learners, such as dyslexia-friendly fonts, audio narration, or minimal visual distractions.

- Assistive Strategies for Dyslexic Learners in Technology-

Research emphasizes multi-sensory learning approaches combining visual, auditory, and tactile cues to improve literacy and comprehension for dyslexic learners. Incorporating such strategies into coding education can help learners better understand logic, sequencing, and debugging. Text-to-speech feedback, scaffolding from blocks to text-based code, and distraction-free interfaces are recommended design features that support dyslexic learners while maintaining engagement in gamified learning environments.

- Research Gap-

While gamification and visual programming have individually shown benefits in coding education, few studies explore the combination of gamification with explicit dyslexia-oriented accessibility features. There is a need for platforms that integrate engaging game mechanics with design elements specifically tailored to reduce cognitive load, improve comprehension, and increase confidence among dyslexic learners. This study aims to address this gap through the development and evaluation of CodeMaze, a gamified and dyslexia-friendly c oding environment.

III. PROPOSED SYSTEMV. RESULTS

- Overview of CodeMaze-

CodeMaze is a gamified coding platform where learners guide an avatar through mazes using programming commands.

- Key Features-

1. Inclusive Design:

Dyslexia-friendly font (OpenDyslexic).
Minimalist UI with high contrast backgrounds. Text-to-speech for instructions and errors.

1. Gamification Elements:

Story-driven progression, levels, and badges. Immediate visual feedback (avatar actions, animations).

1. Scaffolding Approach:

Stage 1: Visual block commands with icons and audio. Stage 2: Side-by-side text code in Python/JavaScript. Stage 3: Full text-based challenges with hints.

IV. METHODOLOGY

The study evaluated the effectiveness of CodeMaze, a gamified coding platform for dyslexic learners, using the following steps:

Step 1: Participant Selection-

30 secondary-level students divided into two groups: Group A (Control): 15 st udents using Scratch. Group B (Exerimental):15dyslexicstudents usingcodemaze.

Step 2: Pre-Test Assessment-
Measured prior coding knowledge, reading/symbol recognition skills, and confidence levels using a questionnaire.

Step 3: Tool Preparation-
Group A: Standard block-based coding exercises (Scratch).
Group B: CodeMaze with dyslexia-friendly fonts, audio instructions, distraction-free UI, gamified puzzles, and block-to-text scaffolded coding.

Step 4: Learning Sessions-
Duration: 5 sessions over 2 weeks (1 hour each).

- Group A completed traditional coding tasks;
- GroupB solved CodeMazep uzzles with visual blocks and audio guidance.

Step 5: Data Collection-
Metrics: engagement (time-on-task), error rate, progress (levels completed), and post-session user feedback.
Teachers/researchers recorded observations of focus, frustration, and strategies.

Step 6: Post-Test Assessment-
Same as pre-test to evaluate improvement in coding skills, confidence, and error reduction.

Step 7: Data Analysis-
Quantitative: Compare engagement, errors, and level completion; use t-tests for pre/post-test improvements.
Qualitative: Analyze feedback and observations for user experience insights.

- Engagement: Group B spent 30% longer on learningtasks than Group A.
- Error Reduction: Syntax-related errors were reduced by 40% in Group B.
- Confidence: 86% of dyslexic learners in Group B reported feeling “more confident” coding.
  - Qualitative Feedback: Learners valued the “easy - to - follow instructions” and “fun challenge- based format.”

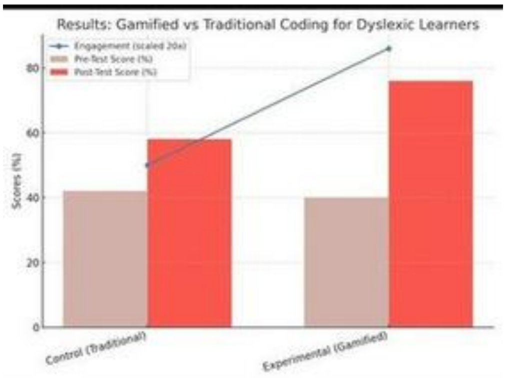

Figure 1: Test Ratio

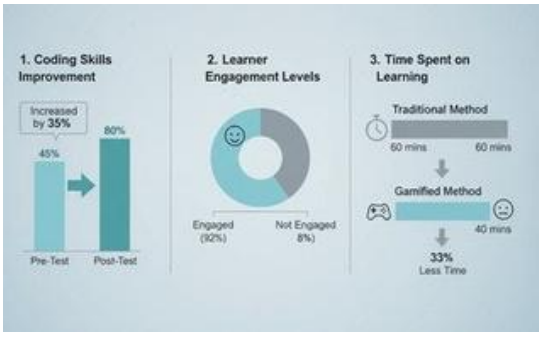

Figure 2: Overview

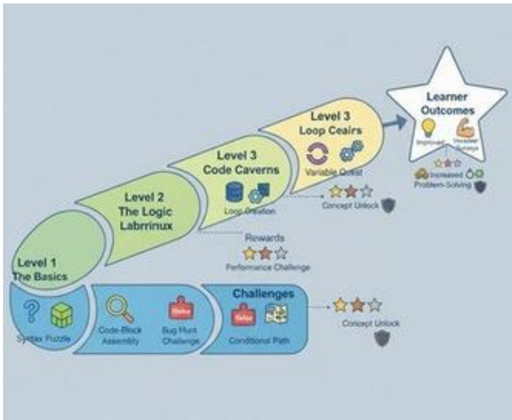

Figure 3: Process

Figure 5: Game Example

Figure 6: Working of the Game

V. CONCLUSION AND FUTURE WORKS

This study demonstrates that gamified coding platforms with inclusive design features significantly improve learning outcomes for dyslexic students. The CodeMaze prototype successfully reduced cognitive load, enhanced engagement, and built learner confidence. Future research should explore adaptive AI-based difficulty scaling, collaborative coding missions, and large-scale trials across diverse age groups. Developing mobile-first versions will further democratize access and extend benefits to broader learner populations.

REFERENCES

[1] Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. Annals of Dyslexia, 53(1), 1–14.

[2] Shaywitz, S. E., & Shaywitz, B. A. (2008). Paying attention to reading: The neurobiology of reading and dyslexia. Development and Psychopathology, 20(4), 1329– 1349.

[3] Snowling, M. J. (2013). Early identification and interventions for dyslexia: A contemporary view. Journal of Research in Special Educational Needs, 13(1), 7–14.

[4] Galuschka, K., Ise, E., Krick, K., & Schulte-Körne, G. (2014). Effectiveness of treatment approaches for children and adolescents with reading disabilities: A meta-analysis. PLoS ONE, 9(2), e89900.

[5] Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." Proceedings of the 15th International Academic MindTrek Conference, 9–15.

[6] Weintrop, D., & Wilensky, U. (2015). To block or not to block, that is the question: Students' perceptions of blocks-based programming. Proceedings of the 14th International Conference on Interaction Design and Children, 199–208.

[7] Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? – A literature review of empirical studies on gamification. Proceedings of the 47th Hawaii International Conference on System Sciences, 3025–3034.