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Gamified LMS For Programming Concepts

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Abstract: Gamification involves applying game mechanics and elements to non-game contexts, like education, to increase engagement and motivation. There has been a growing interest in utilizing gamification in teaching programming concepts in recent years. This study examines the advantages of using gamified learning for programming education, as well as the various strategies and techniques employed to gamify programming instruction. The research also explores the challenges and limitations of gamification in programming education, and proposes potential solutions. The findings suggest that gamification can significantly enhance students' engagement, motivation, and learning outcomes in programming education, while also fostering problem-solving skills, creativity, and critical thinking abilities. These results underscore the importance of designing effective gamification strategies that are tailored to the specific context and learning objectives. The paper concludes by discussing the future directions of gamified learning in programming education and the potential of emerging technologies, such as virtual and augmented reality, to further enhance gamified learning experiences.

Keywords: Gamification, e-learning, gamified approach to education, programming

I. INTRODUCTION

Online games designed for educational purposes can come in different formats, such as simulations, virtual worlds, and games. These games usually integrate various features such as feedback, challenges, levels, badges, and points to motivate learners to take part and compete. Additionally, they may also provide customizable avatars, social interactions, and real-time feedback to create a more engaging and interactive learning environment.

There are many benefits to using online games for learning, including:

Accessibility and Convenience: Online games can be accessed from anywhere and at any time, making them convenient for learners who may have limited time or resources.

Cost-Effectiveness: Online games can be cost-effective compared to traditional learning methods, such as textbooks, classroom instruction, or training programs.

Improved retention and transfer of knowledge: Online games can help learners to better retain and apply what they have learned, as they often involve actively applying knowledge in order to progress or complete challenges.

Enhanced problem-solving skills and critical thinking: Online games often involve solving problems and making decisions, which can help learners to develop their critical thinking and problem-solving skills.

Customized learning experiences: Online games can be customized to suit the needs and preferences of individual learners, making them an effective way to meet the diverse learning needs of students.

Following are the exact ways how Games can actually be implemented as a learning tool:

Game mechanics: Game mechanics are the elements and rules that define how a game works and how players interact with it. In gamified learning, game mechanics are used to motivate and engage learners, and can include elements like points, badges, levels, challenges, and feedback.

Game-based learning: Game-based learning is a type of gamified learning that involves using games as the primary means of instruction. In game-based learning, the game itself is the focus of the learning experience, and the learning objectives are embedded within the game.

Game-based assessment is an approach to measuring and evaluating individuals' knowledge, skills, and abilities by using game mechanics and elements. It involves designing games or game-like activities that simulate real-world scenarios and assess specific competencies or performance indicators. Game-based assessments can provide a more immersive and interactive testing environment than traditional assessment methods, such as multiple-choice tests or exams.

Gamification: Gamification is the process of applying game-like elements and mechanics to non-game contexts in order to engage and motivate people. In gamified learning, gamification is used to make learning more engaging and interactive, and to create a sense of progress and accomplishment for learners.

Learning management systems (LMS): A learning management system (LMS) is a software platform that is used to manage and deliver e-learning courses and programs. Many LMSs have built-in gamification features, such as points, badges, and leader boards, that can be used to gamify learning.

Reinforcement learning is a form of machine learning in which an agent learns to make decisions in an environment by taking actions and receiving feedback in the form of rewards or penalties. The agent employs a trial-and-error approach to explore different actions and their consequences, and based on the feedback, it learns to make optimal decisions to

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maximize its cumulative rewards over time. Reinforcement learning has been successfully applied in diverse domains, such as robotics, game playing, recommendation systems, and autonomous vehicles, as it provides a powerful means to train agents in making complex decisions in dynamic and uncertain environments.

It continues to be an active area of research with significant potential for practical applications in the real world.

Reinforcement learning plays a pivotal role in training agents to make decisions in challenging and uncertain environments where conventional methods may fall short. It empowers agents to acquire optimal behaviours through iterative experimentation, resulting in enhanced decision-making capabilities and performance across diverse domains, including robotics, gaming, recommendation systems, and autonomous vehicles.

II. RELATED WORK

A Gamified learning platforms have gained significant attention in recent years as a novel approach to engage learners and enhance their understanding of complex subjects. Several studies have explored the use of gamified learning platforms specifically for teaching programming concepts, leveraging the inherent motivational aspects of games to enhance the learning experience and improve students' programming skills.

One notable related work in the field of gamified learning platforms for teaching programming concepts is the platform "CodeCombat". CodeCombat is an online platform that offers a gamified learning experience for programming, where students learn programming concepts by controlling characters through levels filled with puzzles and challenges. The platform provides a range of programming languages, such as Python, JavaScript, and Java, and covers various programming concepts, such as loops, conditionals, and functions. Students earn points, unlock new levels, and collect rewards as they progress, providing intrinsic motivation to continue learning and mastering programming skills.

Another relevant example is "Codewars", a gamified learning platform that focuses on providing programming challenges to learners. Codewars offers a vast collection of coding challenges in multiple programming languages, where learners can solve problems and earn points based on their performance. Learners can also engage in friendly competitions with other users, participate in coding tournaments, and track their progress through rankings and achievements, creating a competitive and engaging learning environment.

"Grasshopper" is another gamified learning platform that targets beginners who are new to programming. Developed by Google, Grasshopper offers a mobile app-based learning experience that uses game-like features, such as completing levels, earning achievements, and unlocking new content, to teach fundamental programming concepts in a visual and interactive manner. The platform focuses on JavaScript programming and covers concepts such as variables, loops, and functions, providing a gradual and scaffolded learning experience for beginners.

Furthermore, "Codecademy" is a popular gamified learning platform that offers interactive coding lessons in various programming languages. Codecademy uses a gamified approach, where learners complete coding exercises, earn points, and unlock achievements as they progress through the lessons. The platform also provides a community forum for learners to interact with peers, seek help, and share their progress, fostering a sense of community and social learning.

"RoboGarden" is a gamified learning platform that offers a unique approach to teaching programming concepts by integrating programming with game-based challenges. RoboGarden provides a visual block-based programming interface that allows learners to create and control virtual robots to complete challenges in a game-like environment. Learners earn points and badges as they complete challenges, and the platform offers personalized feedback to guide learners through the learning process.

There are many different game kinds that are utilised in education, such as game-based learning (GBL), a form of game-playing with predetermined learning objectives. Gamification and game-based learning are not the same thing. Gamification is the incorporation of game principles into learning, whereas game-based learning is utilising a game as a learning tool. Gamification, the use of games to improve enjoyment and participation in all facets of life, is exclusively employed in education.

Content Gamification is the application of game elements, game mechanics and game thinking to alter content to make it more game-like. So, beside game elements, there is a change to the content such as providing a story, challenge, curiosity, mystery and characters to content, to engage the learner [6]. Researchers outlined two types of academic motivation—intrinsic and extrinsic motivation. Intrinsic motivation occurs when students engage in learning “For its own sake” and they enjoy it. Some examples are: altruism, competition, cooperation, sense of belonging, and love or aggression. Extrinsic motivation occurs when something or someone pushes the student to make an action, for example: classifications, levels, points, badges, awards, missions. The process of modifying content to make it more resemble a game involves using game mechanics, game elements, and game thinking. In order to interest the student, there is a change to the material in addition to the game aspects, such as adding a plot, challenge, intrigue, mystery, and characters [6]. Extrinsic and intrinsic motivation were identified by researchers as the two main categories of academic motivation. When pupils like learning "for its own sake," they are intrinsically motivated to do so. Altruism, rivalry, teamwork, a

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sense of belonging, and love or violence are a few examples. When something or someone forces a student to act, such as through classifications, levels, points, badges, awards, or missions, this is known as extrinsic motivation.

The Covid-19 Pandemic has had a significant impact on educational institutions at all levels, including pupils in kindergarten, primary school, secondary school, and even universities. The education sector must be shut down in order to stop the transmission of the coronavirus and lower the epidemic. To enable sufficient social separation, practically all teaching has quickly migrated to distant learning (Johnson et al., 2020). It was challenging to plan empirical research that investigated the usage of gamified tools because of the COVID-19 outbreak's fast development, and most instructors were making great efforts to switch from in-person lectures to online lectures via videoconferencing tools (Nieto-Escamez and Roldan-Tapia, 2021). Present-day lecturers need to pay attention to the growing issue of students who are losing interest in and motivation for their classes.

Many institutions have started using gamification concepts or apps to improve students' learning experiences, but it's crucial to find the best technique to guarantee that the students are effectively learning through gamification. (2013) Stott and Neustaedter Gamification has a favourable effect on subsequent behaviours like participation and academic achievement to raise students' educational level, especially over the short term. (Nekuchaev, Ponomarev, and Golubovski, 1998). The previous researcher also addressed the necessity for educators to create new teaching tactics in order to increase students' enthusiasm and commitment in online classes. Gamification is one method that educators have become interested in recently as they have been researching.

Kahoot is a student response system that draws students in with pre-planned or impromptu tests, conversations, and surveys in the style of games. The quiz can be accessed by students from any device with a web browser, including an iPad, mobile device, or laptop, and they don't require a Kahoot account to do so. To design the quiz, the instructor will nevertheless require a login. It is quick and simple to create surveys, debates, and quizzes. (2015) Dellos The Kahoot application is simple to use and has gained popularity for encouraging student collaboration to win. The fact that this application is both web-based and free, as well as being compatible with mobile devices, is its largest benefit.

The scoreboard system functions similarly to a scoreboard that presents a ranked and sorted list, and it effectively displays students' total performance. Around 70 pupils were subjected to Dr. Carman Neustaedter's application of gamification principles using a scoreboard system. When the course was examined, it was clear that there was some freedom to fail, that progress was being made, and that narrative was being used. (2013) Stott and Neustaedter. Additionally, because they can visually and digitally detect changes in ranking as a result of recent uploads, it demonstrates how certain coursework affects their score. It should be emphasised that employing points is not the sole factor in the scoreboard's efficiency.

The scoreboard helps motivate people because accomplishments are intimately tied to opportunities for the future and prior successes. For instance, students who are only 50 XP behind the students in front of them might be more motivated to work harder for the upcoming assignment if the "B" grade students decide they are happy with their existing grades and solely care about them.

The Covid-19 pandemic has had a catastrophic impact on society, economy, and politics as well as on people's health throughout the world (Arnove, 2020). Universities were harmed by this because several nations closed buildings, forcing instruction to shift nearly immediately to online delivery. Students at all educational levels have been greatly impacted by the sudden changes brought on by the pandemic. To address the academic lag caused by the Covid-19 epidemic, educators must create the best learning environments possible (American Psychological Association [APA], 2020; Daniel, 2020).

According to current educational trends, instructors prefer active learning, which places the student at the centre of the learning process (Tharayil et al., 2018). Therefore, according to a number of studies, active learning transitions pupils from memorization to a more fulfilling learning experience (Aji & Khan, 2019). According to Freeman et al. (2014), students who participate in active learning are less likely to fail a class or leave school altogether than those who attend traditional instruction. Students typically earn better grades when teachers refrain from 2021, page 37 of the Australasian Journal of Educational Technology (5). Set clear learning objectives, limit distractions, and give students opportunities to communicate and ask questions in secure areas.

The students in the two undergraduate classes felt that the gamification method encouraged them to show up to class, participate, and complete the assignments during the lockdown brought on by the Covid-19 pandemic. These results are consistent with those of Park et al. (2019) and Morschheuser et al. (2019), who discovered that students thought receiving a benefit after completing a task or activity was a pleasurable experience. In this way, the findings of the study demonstrated how gamification in higher education, when combined with a reward system, can engage and encourage students in a challenging online learning environment. The study also showed that the reward system might increase flow and encourage students to participate in the course.

Games are an integral part of human life, regardless of age or gender, according to several anthropological research studies (Santos-Guevara & Rincon-Flores, 2021; Smiderle et al., 2020; Stefani et al., 2014). Due to the acknowledgement of the student's cognitive abilities, attitudes, and values, as well as the atmosphere of healthy competition created by the

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reward system, gamification as part of educational strategy can make learning settings into more fun processes. We also draw attention to a fascinating finding that supports the notion that gamification is interactive.

III. PROPOSED SYSTEM

All The proposed system is a Learning Management System (LMS) which is hosted online. This LMS will have a user login which allows for authentication and verification. The users who register to the lms will have access to their progress in the learning flow.

The system will have a dashboard with a list of languages user can learn, and a list of the various levels when the user clicks on any language.

Each language has a detailed installation steps to help the user install the languages on their own systems for personal use. Each level has a specific set of concepts that user can learn and a different type of game they can play to reinforce that learning.

A. Auth0

The Auth0 is a prominent identity and access management (IAM) platform that provides secure authentication and authorization solutions for modern applications. Founded in 2013, Auth0 has become a leading provider of IAM services, catering to the needs of organizations of all sizes and industries. Auth0's platform offers a wide range of features and capabilities, including social media login integration, multi-factor authentication, single sign-on (SSO), and more, making it a popular choice for developers and enterprises alike.

One of the key strengths of Auth0 is its flexibility and ease of integration. Auth0 supports a wide variety of authentication protocols and standards, including OAuth, OpenID Connect, SAML, and more. This allows developers to easily incorporate Auth0 into their applications, regardless of the programming language, framework, or platform being used. Auth0 also provides extensive documentation, libraries, and SDKs for popular programming languages, making it straightforward for developers to implement secure authentication and authorization mechanisms in their applications.

Auth0 also stands out for its comprehensive security features. The platform includes built-in security measures, such as brute-force protection, anomaly detection, and risk-based authentication, to protect against common security threats. Auth0 also supports multi-factor authentication (MFA) through various methods, such as SMS, email, and third-party authentication apps, to provide an additional layer of security. Additionally, Auth0 undergoes regular security audits and compliance certifications, such as SOC 2, GDPR, and HIPAA, ensuring that it meets industry standards for security and privacy.

While Another notable feature of Auth0 is its support for social media login integration. Auth0 allows users to authenticate using their existing social media accounts, such as Google, Facebook, Twitter, and more. This eliminates the need for users to create new accounts and passwords, making the authentication process more convenient and user-friendly. Auth0 also provides features such as social media profile data retrieval and social sharing, enabling developers to leverage social media data in their applications to personalize user experiences and enhance engagement.

Auth0 also offers a rich ecosystem of integrations and extensions, providing additional functionalities to enhance the IAM capabilities of the platform. Auth0 integrates with popular identity providers, such as Microsoft Azure AD, Google Cloud Identity, and AWS Cognito, allowing for seamless integration into existing authentication workflows. Auth0 also offers numerous extensions for popular development frameworks, such as Angular, React, and Node.js, making it easy for developers to integrate Auth0 into their preferred technology stack.

In conclusion, Auth0 is a leading IAM platform that offers flexible and secure authentication and authorization solutions for modern applications. Its ease of integration, comprehensive security features, support for social media login integration, and rich ecosystem of integrations and extensions make it a popular choice for developers and enterprises. Auth0's focus on security, scalability, and ease of use has made it a trusted solution for thousands of organizations worldwide, providing a seamless and secure user authentication experience.

B. Tailwind CSS

Tailwind CSS is a utility-first CSS framework that allows developers to quickly and easily create custom user interfaces. The framework provides a range of pre-defined CSS classes that can be used to style HTML elements without the need for custom CSS. Tailwind CSS includes a wide range of pre-defined classes for layout, typography, colours, and spacing, making it easy for developers to create a consistent and visually appealing user interface. Tailwind CSS also provides a

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responsive design system that allows developers to easily create mobile-friendly designs that adapt to different screen sizes.

One of the key benefits of using Tailwind CSS is its flexibility. The framework allows developers to create custom designs by combining pre-defined CSS classes. This makes it easy to create unique user interfaces that reflect the branding and style of the application. Tailwind CSS also provides a range of configuration options that allow developers to customize the framework to suit their specific needs. For example, developers can choose which colours and font families to use, and can configure the breakpoints used in the responsive design system.

Another benefit of using Tailwind CSS is its ease of use. The framework provides a simple and intuitive API that can be learned quickly by developers with basic knowledge of HTML and CSS. The pre-defined CSS classes are easy to remember and use, and the documentation is comprehensive and easy to follow. Additionally, Tailwind CSS integrates well with popular front-end frameworks such as React and Vue.js, making it a popular choice for developers looking to create modern web applications.

C. React JS

React is a popular JavaScript library for building user interfaces that is well-suited for gamified learning projects.
Reusable components: React allows us to create reusable components that can be easily shared and customized. This helps in decreasing the development time.
Fast performance: React is designed to be fast and efficient, which is important for a gamified learning project that will require frequent updates to the user interface.
Compatibility with other libraries: React is designed to be compatible with a wide range of libraries and tools, which means that we can easily integrate it with Unity which is a central tool for the gamified learning project.
Good for building interactive UIs: React is particularly well-suited for building interactive user interfaces, which can be important for creating engaging and immersive gamified learning experiences.
So, overall user has to go through user authentication as previously mentioned. Later, an introductory quiz will be done to evaluate user expertise and accordingly games will be displayed to give them an upskill. Leadership board will display user progress as well as they compare their scores with other members playing the same game but they can also keep this score board according to their preference.

IV. LEARNIFY MANAGEMENT SYSTEM

A. Login

Login of the user is facilitated by the use of Auth0 technology, this provides them a quick and secure log in to their account where their progress of the game as well as their score of previous games will be scored.
Auth0 provides flexibility and ease of integration as it supports wide variety of authentication protocols and standards.

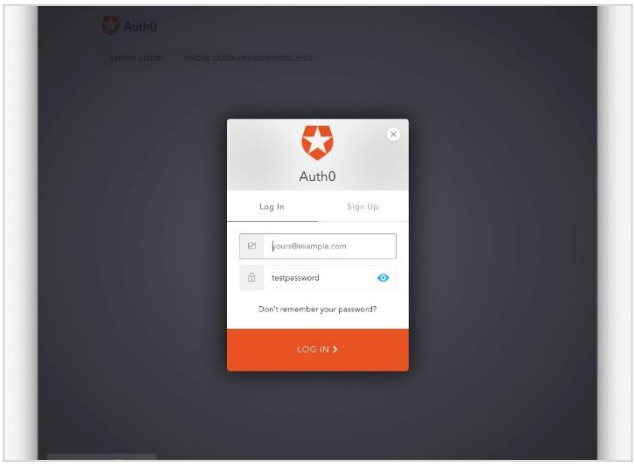

Fig. 1 AUTH0 LOGIN

B. Dashboard

The Learnify platform's dashboard serves as a main page, providing access to all other panels and allowing users to securely log in to their account by entering their login information.

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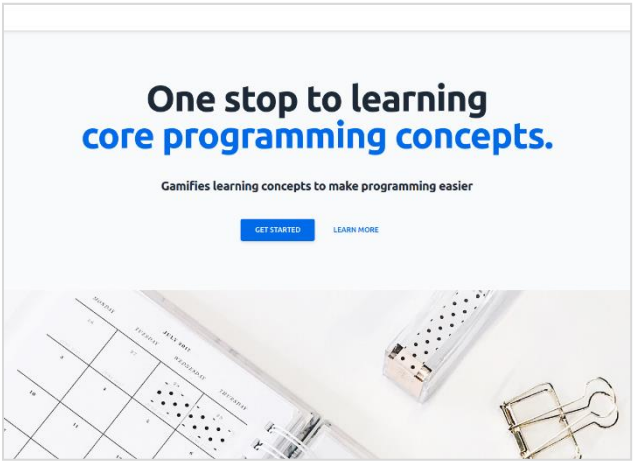

Fig. 2 DASHBOARD

C. Dashboard

The Learnify Management System works by providing a platform for the user to learn different programming concepts by playing different kinds of games. All the levels of the game will comprise of introduction to the concept on which the game will be based, as well as video and audio of the concepts are provided. Few of the games that has been integrated in this platform are:

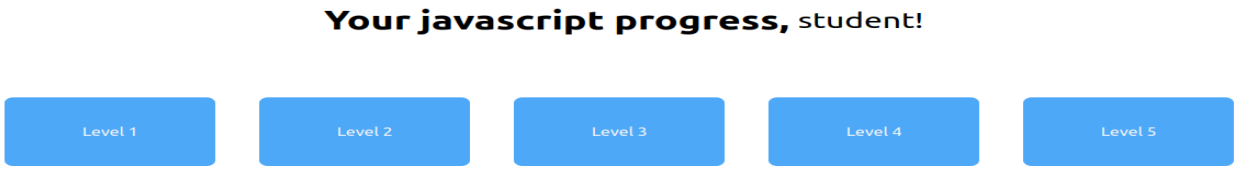

Fig. 3 LEVELS

D. Level 1

The Level 1 of a platform comprise of “Tic Tac Toe” game, where the user will have to place cross on a nine square board but before that they’ll have to answer a question related to programming concept of the language that they have selected at the beginning of the game.

“Tic Tac Toe” game will allow user to enter cross in any of the place on the nine square board, and after successfully answering the question, the computer will place the ‘zero’ on the board.

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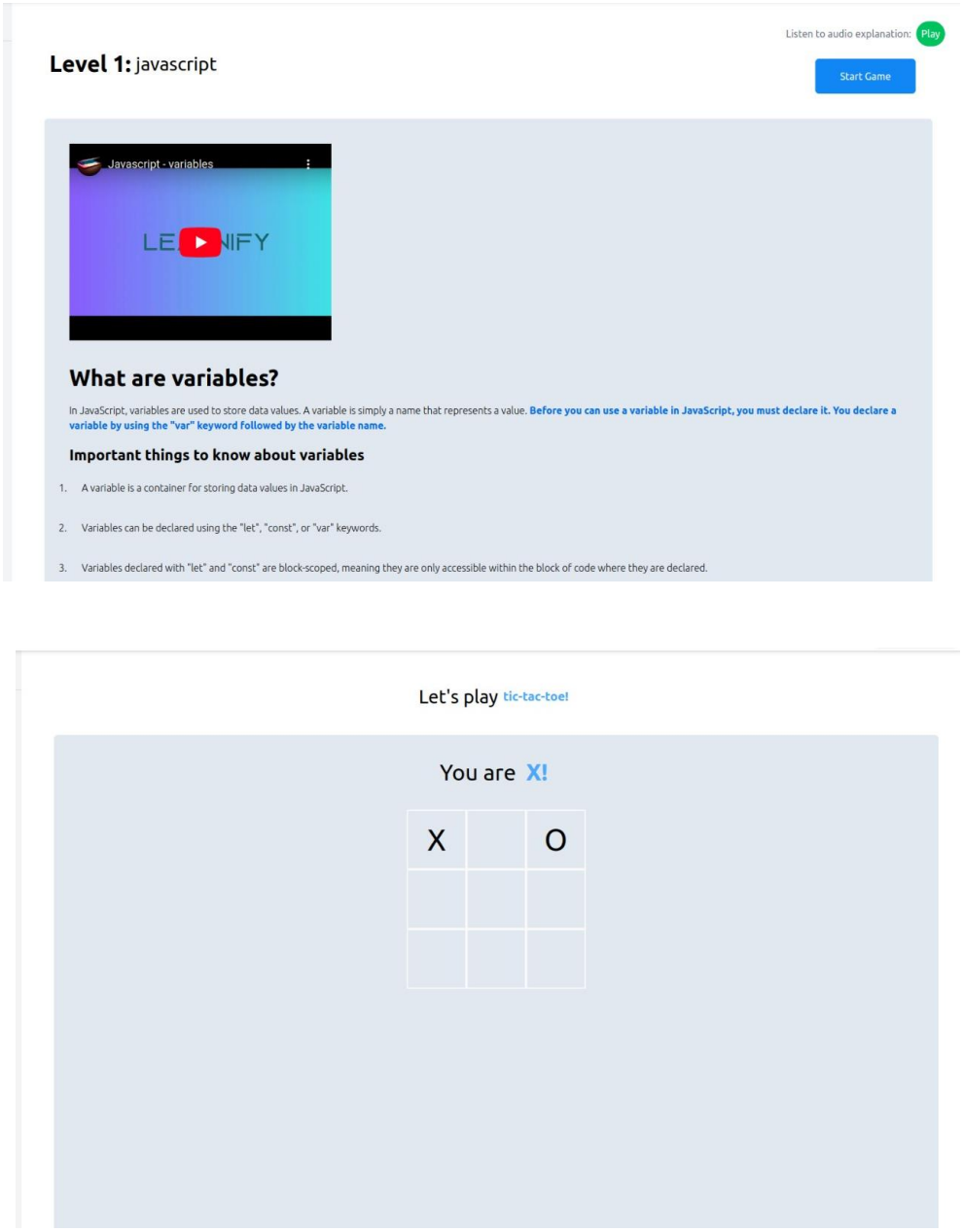

Fig. 4 LEVEL 1

E. Level 2

The Level 2 will comprise of "Memory game" where user will be provided with a 16-deck card, with a pair of two. They will get a glimpse of face up card for few seconds before it's turned and then when the user selects a card, they have to answer a specific question, then only the matching card will be turned face up.

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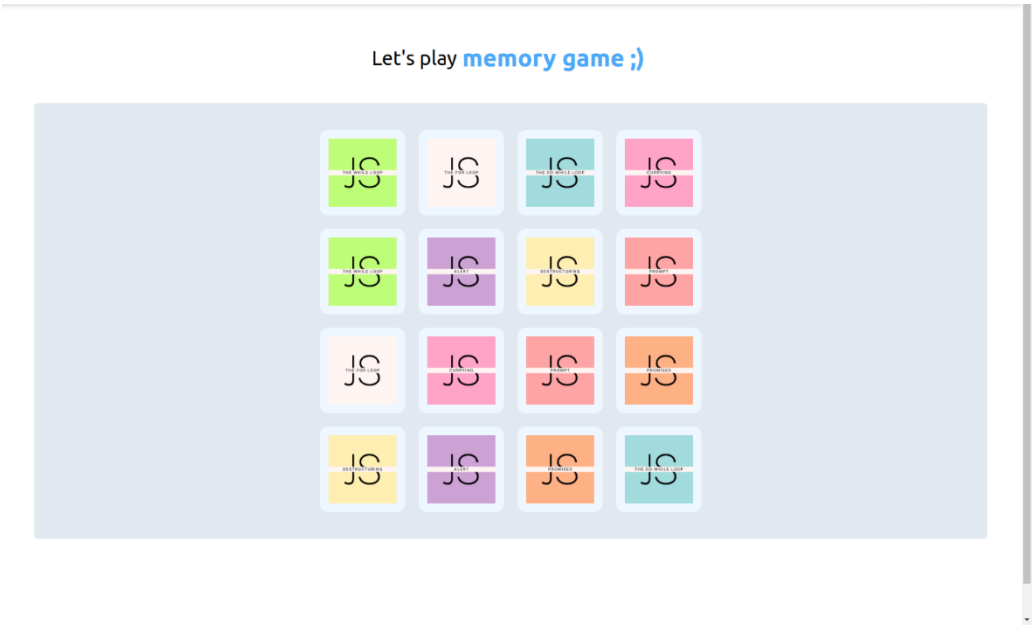

Fig. 5 LEVEL 2

F. Level 3

The Level 3 platform will have “Lights Out” game , where "Lights Out" is a puzzle game that challenges players to turn off a grid of lights by toggling them on and off. The game typically consists of a rectangular grid of buttons or lights that are initially in either an on or off state. When a player selects a button or a light to toggle, the selected button and its adjacent buttons (usually horizontally and vertically) also change their state, from on to off, or from off to on. The goal of the game is to turn off all the lights on the grid in the fewest number of moves possible. By doing so the user will have to answer few programming related questions. User will have to answer multiple choice questions.

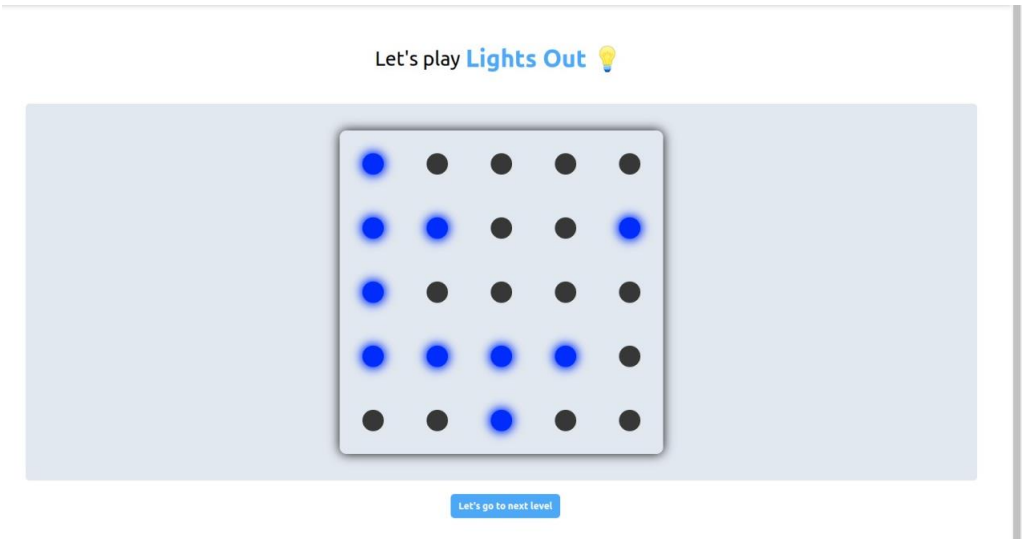

Fig. 6 LEVEL 3

G. Level 4

The Level 4 of this gaming platform will contain “Fill in the blanks” game where the user will have to answer what the missing syntax is in the block of code.

User will have to answer questions in order to score points, then only will they be able to proceed onto the next level.

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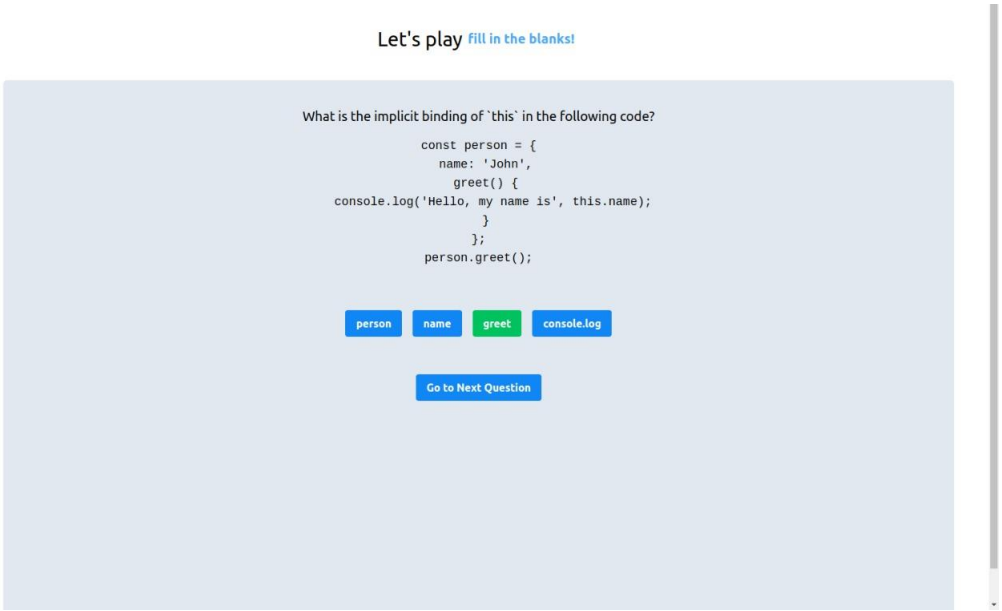

Fig. 7 LEVEL 4

H. Level 5

The Level 5 however will comprise of "Revision" of all the modules user have learned so far, this will help them getting a quick overview of the programming concepts.

I. Scoreboard

The Scoreboard will comprise of storing the updated scores of the user as well maintaining a panel where they can compare score from the other users who have played the same game so as to invoke a sense of competition in them.

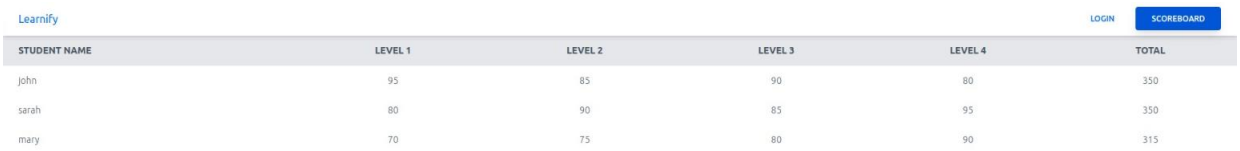

Fig. 8 SCOREBOARD

V. WORKFLOW OF LMS

First the user will login and will be directed to the dashboard. From there, user can select the preferred programming language, comprising of options like C, C++, Java, JavaScript, python and even the basic concepts.

After selecting the language, they'll be directed to the panel that'll comprise of five levels, as discussed earlier. If the user losses, they'll be re directed to the level panel and will have to play the same level again until they have scored a minimum score to board onto next level. If they win, they'll be directed to next level or if all levels are played, they'll be directed to score board.

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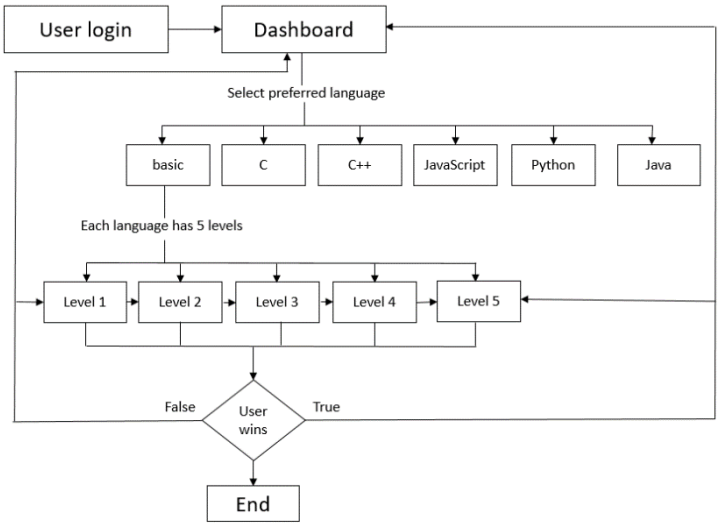

Fig. 9 WORKFLOW DIAGRAM

VI. CONCLUSION

For students of all ages and skill levels, a gamified learning environment for programming fundamentals might be an invaluable tool. It has the ability to make learning more engaging and motivational by including game-like components like points, badges, and leaderboards. Additionally, engaging, practical exercises and activities might improve learning. recognize and remember programming ideas. A platform like this might be used to enhance conventional programming courses or as a stand-alone tool for independent study. In general, a gamified learning environment could improve the effectiveness and accessibility of learning programming ideas for a variety of students.

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