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DevMind: Educational Programming Environment for Beginners

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Abstract: The landscape of programming education has rapidly evolved with the emergence of online learning platforms, revolutionizing how beginners acquire essential coding skills. This research introduces "DevMind," a groundbreaking Educational Programming Environment meticulously designed to cater to JavaScript beginners with limited prior knowledge. This innovative platform encompasses a rich array of features, including a cutting-edge AI-based virtual mentor, a collaborative code review and feedback system, and a versatile cloud-based Integrated Development Environment. Drawing inspiration from the successes of systems like "CodeMage," DevMind sets out to address the pervasive challenges confronting novice programmers as they navigate the intricate world of coding. DevMind's primary objective is to redefine the learning journey of aspiring JavaScript programmers, bridging the divide between theoretical understanding and hands-on coding proficiency. This paper embarks on a comprehensive exploration of the platform's architecture, meticulously dissecting its multifaceted features and assessing its transformative impact on programming education. Through a thorough review of relevant literature, DevMind's distinctive and pioneering contributions are meticulously illuminated, highlighting its potential to reshape the educational landscape for budding JavaScript enthusiasts. In an era marked by dynamic technological advancements, DevMind emerges as a beacon of innovation, poised to empower, and embolden learners on their quest to master the art of coding.

Keywords: educational programming environment, novice programmers, AI-based virtual mentor, javascript

1.   Introduction

As the demand for accessible, interactive tools that meet the needs of beginners grows, the field of programming education has recently seen a revolutionary shift toward online learning platforms [1]. These platforms are crucial in bridging the knowledge gap between academic understanding and practical coding abilities. Notably, a new era of learning opportunities for beginning programmers has begun with the emergence of AI-driven teaching environments [2]. The architecture and operation of "DevMind," a ground-breaking online Integrated Development Environment (IDE) that effortlessly incorporates the power of Artificial Intelligence (AI) into programming education, are examined in this research paper. With many languages and technologies available today, learning to program might be challenging for beginners. Even while they are instructive, traditional educational tools might not provide students with the hands-on experience necessary to develop their skills. DevMind, a programming environment designed specifically for beginners who are interested in learning JavaScript, responds by offering a user-friendly interface combined with AI-driven capabilities to speed up the learning of programming [3].

This paper's main objective is to investigate the distinctive qualities that set DevMind apart from other IDEs. The platform's features are built on three key pillars: "Project Vault," "Code Review and Feedback," and "Cloud-Based IDE." The instructional structure of DevMind is built on each of these elements. The platform stands out for its AI-based Virtual Mentor, which provides in-the-moment support, solution suggestions, and clearer explanations of complicated programming topics [4].

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This study paper will examine the unique characteristics of each DevMind platform feature in the subsections that follow. For instance, the "Project Vault" feature enables users to effectively manage their coding projects and produce detailed reports outlining project specifics. "Code Review and Feedback" functionality, highlighting its collaborative nature and use of AI to improve learning [5] will be examined. The "Cloud-Based IDE" will also be evaluated in order to shed light on its distinct capabilities and reporting frameworks. Finally, AI-based Virtual Mentor, DevMind's key innovation, and explore the technology that powers this virtual mentor [6] will also be examine.

By the end of the paper, it will be clear that DevMind goes beyond the limitations of a typical online IDE, emerging as a game-changing facilitator in programming education. Because of its integrated features, learning may be expedited through practice, feedback, and group exploration. Platforms like DevMind demonstrate the enormous impact of AI on education and enable people to realize their full coding potential as technology continues to change the programming landscape [7].

The structure of this research paper is as follows: The subsequent sections encompass a comprehensive literature review, highlighting the platform's unique contributions and inspirations, and exploring the landscape of competitors. The methodology section outlines the systematic approach taken in designing and building DevMind, emphasizing the integration of an AI-based Virtual Mentor and other key features. The paper will present, discuss, and analyze the results of implementing DevMind for novice JavaScript programmers, offering recommendations for future research. Finally, the paper concludes by discussing the implications of DevMind's features, its pedagogical considerations, and the potential future impacts of this innovative platform on the world of programming education.

2. Literature Review

The introduction of online learning platforms that provide easily accessible and interactive tools catered to the needs of novices has accelerated the growth of programming education [1]. These platforms help new programmers transition into a vibrant learning environment by bridging the gap between theoretical knowledge and practical coding skills. The use of artificial intelligence (AI), which has given programming instruction new levels of engagement and effectiveness, is a recent development in this field.

In light of this, the current research article examines the structure and features of DevMind, a ground-breaking online Integrated Development Environment (IDE) that combines the power of AI with programming instruction. DevMind's main objective is to offer a thorough instructional environment designed especially for new programmers. This platform offers a user-friendly interface together with AI-driven capabilities to make it easier to learn how to program, acting as a conduit for immersive learning [2].

DevMind appears as a solution to the problems that new programmers run with when learning the language. While traditional programming books and courses are interesting, they frequently lack the hands-on experience needed to cement ideas and develop practical skills [8]. This shortcoming prevents a smooth transition from theoretical understanding to efficient coding procedures. In response, DevMind comes in as an Educational Programming Environment for Beginners, providing a variety of tools to address these issues and give students the confidence they need to start their coding adventure.

The "Project Vault," "Code Review and Feedback," and "Cloud-Based IDE" are the three main pillars of DevMind's functionality. Each of these pillars has been thoughtfully created to offer beginning programmers the best possible learning environment [9]. DevMind also adds a ground-breaking component: an original AI-based Virtual Mentor that improves learning by offering real-time support, making suggestions, and demystifying difficult programming ideas [4].

The idea behind the creation of DevMind in the following sections of this literature study by talking about a system called "CodeMage" will be examined. "CodeMage" served as an inspiration for the development of DevMind, and its avant-garde features influenced the appearance and features of the latter platform.

The developers of DevMind took inspiration from a system comparable to "CodeMage" in their quest to create an effective and cutting-edge educational programming environment for novices. "CodeMage" is a significant

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initiative that aims to give beginning Java programmers access to an interactive and instructive programming environment [10]. The system introduces a few features that are intended to alleviate the difficulties that newcomers frequently run into, changing how beginners' approach and use Java programming.

"CodeMage" is distinguished by its dedication to real-time reviews and coaching. The confusing error messages and cautions that hamper novice programmers' learning process are a common problem [10]. This issue is addressed by "CodeMage", which gives trainees immediate feedback to help them spot and fix problems while they code. By reducing irritation, this cutting-edge feature not only promotes a deeper comprehension of coding ideas but also cultivates a positive learning environment.

Additionally, "CodeMage" provides a visual debugger, a hinting system for best practices, and a code generation tool. With the help of all of these resources, beginners should be able to traverse the complexities of coding without feeling overwhelmed [10]. By using a code generation tool, instructors can help students better understand coding patterns and see code structures.

Additionally, two standout elements that support CodeMage's all-encompassing teaching strategy are its virtual instructor and database manipulation tool. These systems encourage interactive learning by letting students interact with databases and ask for help from distant tutors when they run into problems [10]. This interactive assistance system is in line with the educational philosophy of establishing a setting that fosters the development of both theoretical knowledge and real-world problem-solving abilities.

The success of "CodeMage" in meeting the requirements of beginning programmers served as the basis for the creation of DevMind. The designers of DevMind were aware of how much CodeMage's features improved the learning experience for beginners, and they drew on these observations to influence the layout and functionality of DevMind's educational programming environment.

In the realm of online Integrated Development Environments (IDEs), numerous platforms have emerged to cater to the programming education needs of beginners. These platforms offer a range of features and functionalities aimed at fostering an effective and engaging learning experience. Understanding the landscape of these competitors provides valuable context for the development and positioning of DevMind.

One notable competitor in the field of online IDEs is "CodeCraft," a platform designed to provide hands-on coding experiences for novice programmers [11]. CodeCraft emphasizes collaborative learning through real-time coding sessions and code-sharing capabilities. The platform's interactive coding challenges and instant feedback mechanisms align with the broader trend of providing learners with active learning opportunities.

Similarly, "Programmer's Playground" offers a playful environment for beginners to experiment with coding concepts [12]. The platform integrates gamification elements to engage learners and motivate them to practice coding. By framing coding challenges as puzzles and games, Programmer's Playground aims to create an immersive and enjoyable learning journey.

"CodeWizard" takes a unique approach by integrating AI-powered code analysis to provide real-time feedback to learners [13]. The platform's intelligent suggestion system assists learners in identifying and correcting errors, promoting self-directed learning. This AI-guided approach resonates with the AI-based Virtual Mentor feature of DevMind. Understanding the strengths and weaknesses of these competitors informs the development and positioning of DevMind within the programming education landscape. By drawing inspiration from successful platforms and addressing the gaps in existing offerings, DevMind aims to provide a comprehensive and effective educational programming environment for beginners.

The development of online learning platforms that meet the demands of beginning programmers has had a significant impact on the progress of programming education. These platforms have filled the gap between theoretical understanding and actual coding abilities, turning inexperienced students into capable programmers [1]. Aspiring programmers' learning experiences have been improved by the introduction of a new dimension of engagement and effectiveness brought about by the integration of Artificial Intelligence (AI) into this educational environment. [2].

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The unique online Integrated Development Environment (IDE) DevMind arises as a solution to the difficulties experienced by new programmers. Project Vault, Code Review and Feedback, and Cloud-Based IDE, the platform's three major features, offer a comprehensive learning ecosystem that promotes skill development, teamwork, and hands-on coding experience. DevMind's AI-based Virtual Mentor, however, is its distinguishing characteristic [4]. This tool makes learning programming a collaborative process by providing real-time support, suggesting fixes, and demystifying challenging ideas.

The popularity of "CodeMage" an interactive educational programming environment geared toward beginning Java programmers, served as DevMind's inspiration for creation [10] DevMind was developed as a result of CodeMage's emphasis on real-time coaching, code generation, visual debugging, and interactive learning tools. DevMind's design and functionalities have been influenced by the dedication of CodeMage to solving the problems experienced by beginners.

The variety of options available to beginning programmers is further highlighted by the landscape of online IDE rivals [12]. Collaborative coding, gamification, and AI-guided analysis are just a few of the features that platforms like "CodeCraft", "Programmer's Playground", "LearnCode", and "CodeWizard" have added. Knowing the rivals helps to create DevMind and emphasizes the need for cutting-edge features to improve programming education.

3.   Methodology

The objective of the research endeavor is to systematically methodically design, build, and assess an AI-powered virtual assistant seamlessly integrated into the DevMind online code editing platform, with a specific focus on catering to the learning needs of novice programmers. This methodology unfolds through a series of meticulously planned stages, each designed to holistically gauge the impact of the assistant within the realm of coding education.

To realize this aim, embraced a judicious approach that harnessed the inherent potential of the MERN (MongoDB, Express.js, React, Node.js) stack, a renowned ensemble celebrated for its exceptional adaptability in molding dynamic web applications [14]. In a manner akin to the pivotal work that scrutinized inventive solutions for mitigating challenges faced by neophyte programmers navigating the intricate coding landscape, this study assumes the mantle of an in-depth exploration into how the innovative facets of DevMind serve as potent resolutions to these very challenges.

The culmination of the methodological quest is the meticulous cultivation of the DevMind platform, sculpted with meticulous care into a coherent and scalable entity. This achievement is marked by the embodiment of a distributed system architecture, elegantly spanning three tiers that synergistically fortify its foundation. In the subsequent sections, the spotlight will illuminate the distinct features that constitute the essence of DevMind. Each of these features, akin to individual brushstrokes on a canvas, contributes harmoniously towards the overarching vision of transforming novice programmers into proficient coders.

3.1   Editor

The Editor component of DevMind forms the backbone of the platform, providing users with a workspace to write and modify code. The implementation involves integrating a user-friendly code editor interface within the web application. "CodeMirror", renowned for its extensibility and compatibility with various programming languages, is utilized. This editor's adaptability ensures a seamless coding experience for beginners. CodeMirror is a code editor component for the web. It can be used in websites to implement a text input field with support for many editing features and has a rich programming interface to allow further extension [15].

The CodeMirror editor within DevMind encompasses an array of user-friendly features meticulously designed to enhance the coding experience for novice programmers. Syntax Highlighting is a prominent feature that automatically colorizes different code elements, such as keywords, variables, and comments, according to their functions. This intuitive colorization not only makes the code visually appealing but also aids users in quickly identifying errors and grasping the code's structure. Additionally, Auto-indentation is seamlessly integrated, ensuring that code blocks are automatically formatted to adhere to best coding practices, thus enhancing code

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readability. Real-time Error Checking is another indispensable feature that constantly monitors the code as users' type, promptly highlighting syntax errors or potential issues. This real-time feedback empowers users to correct mistakes immediately, promoting a learning environment conducive to error correction. Furthermore, the editor offers Autocomplete and Suggestions, providing users with context-aware code suggestions and auto-completion for variables, functions, and code snippets. These suggestions not only expedite the coding process but also reduce errors, making the DevMind editor a valuable tool for novice programmers seeking a supportive and efficient coding environment.

3.2   AI-based Virtual Mentor

The AI-based Virtual Mentor feature is integrated into the platform to provide real-time assistance and guidance to users. This integration leverages the ChatGPT API, a cutting-edge language model, to facilitate dynamic conversations with the AI mentor. The AI model undergoes fine-tuning to suit the needs of novice programmers. Through the API, users can interact with the AI mentor to seek explanations, receive code suggestions, and unravel complex programming concepts. For instance, when a user provides JavaScript code and runs it in the integrated development environment (IDE), if they encounter any confusion, they can simply click the "Explain" button. Upon clicking, the system will generate an explanation of the code, providing the user with a clear understanding of its functionality and purpose. Refer figure 1. This AI component empowers users to learn and troubleshooteffectively, fostering a supportive learning environment.

Fig 1: DevMind AI-based virtual mentor code explaination

3.3   Cloud-Based IDE

The Cloud-Based IDE aspect of DevMind allows users to store, retrieve, and manage their code projects within a cloud environment. MongoDB Atlas, a cloud-based database service, is utilized to store users' code snippets and projects securely [16]. The "Create," "Read," "Update," and "Delete" functions are implemented to enable users to manage their coding repository seamlessly. This functionality ensures accessibility to previous codes and facilitates efficient project management. Refer figure2.

Fig 2: DevMind Cloud-based IDE

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The Code Review feature fosters collaborative learning by enabling users to seek feedback from experienced members or peers. The "Invite" functionality permits users to invite reviewers who assess their code snippets or projects. This collaborative environment enhances the learning experience, as users receive constructive

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feedback and recommendations to improve their coding practices. Reviewers' feedback is recorded and stored for future reference.
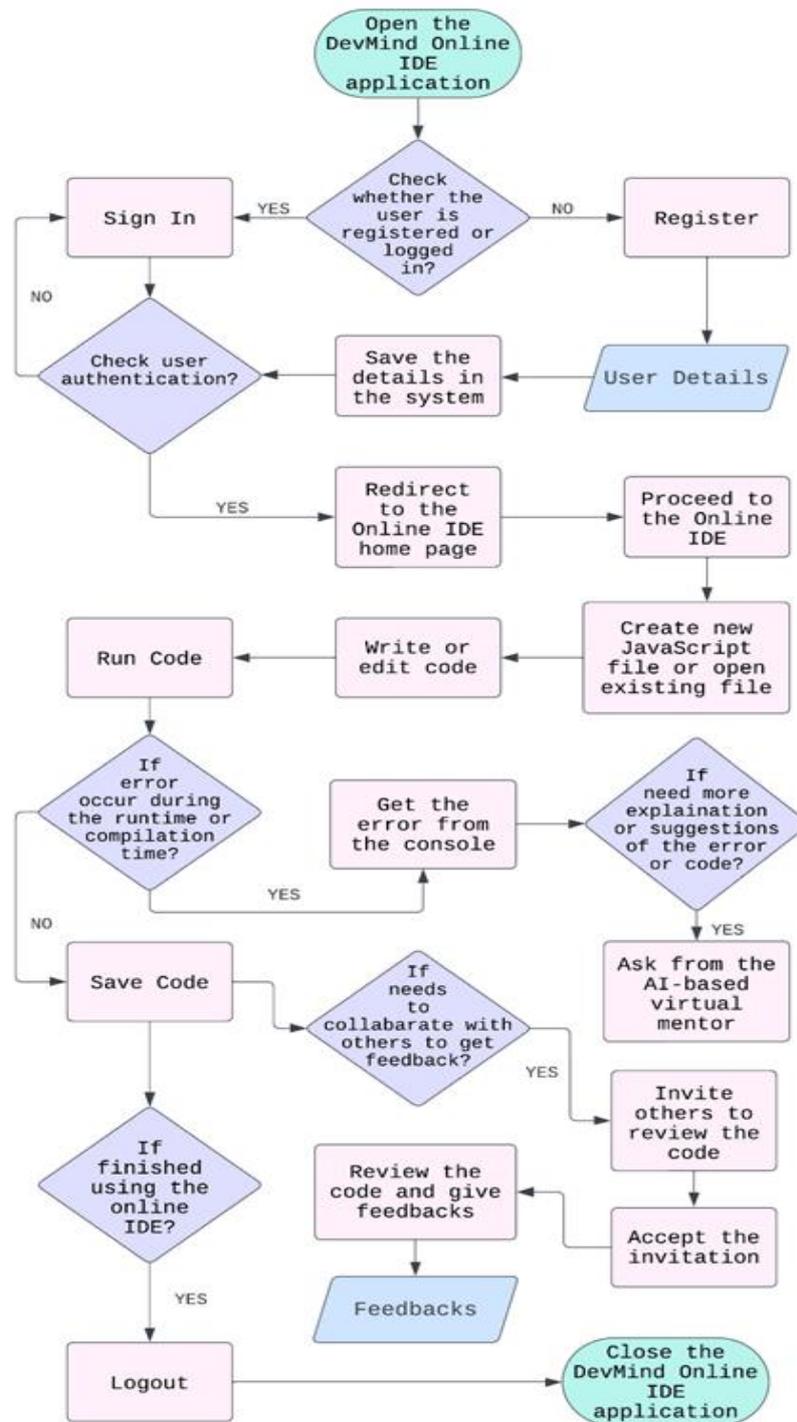

Fig 3: DevMind System Flow Diagram

3.5   Feedback

The Feedback mechanism within DevMind empowers users to engage in meaningful discussions about code improvements. The platform facilitates a structured environment for users and reviewers to exchange comments and suggestions directly within the code editor interface. These conversations provide valuable insights into coding practices, logic, and design choices, contributing to the users' learning journey.

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3.6　　　Comparative Analysis

This involves conducting a comparative analysis of DevMind against existing educational programming environments and online IDEs. By selecting relevant competitors such as "CodeCraft," "Programmer's Playground," and "CodeWizard," one can assess how DevMind distinguishes itself in terms of features, user experience, and learning outcomes. This analysis considers aspects like user engagement, learning effectiveness, AI integration, collaborative features, and user feedback mechanisms. The goal is to highlight the unique contributions and advantages of DevMind in catering to the needs of novice JavaScript programmers. This comparative analysis provides valuable insights into DevMind's position within the programming education landscape.

The development and implementation of DevMind adhered to iterative agile practices. Regular development sprints, code reviews, and continuous integration processes ensured a robust and functional platform. The iterative nature of the development process allowed for regular user testing and feedback incorporation, enhancing the platform's usability, and addressing user needs effectively.

Readers are encouraged to refer the above figure3 to the accompanying flow diagram for a succinct visual overview of the DevMind platform's key features and user interactions. The flow diagram visually encapsulates the platform's intricate ecosystem, providing a quick and informative snapshot of how users navigate and engage with DevMind's integrated components. It serves as an invaluable companion to this methodology, offering a concise and insightful glimpse into the multifaceted nature of the DevMind platform.

4.　　　Discussion

The integration of DevMind, an Educational Programming Environment for Beginners, signifies a transformative advancement in programming education. This section delves into the implications of its features, pedagogical considerations, and potential future impacts.

The standout feature of DevMind is its AI-based Virtual Mentor, which provides real-time guidance and solutions, fundamentally reshaping the learning process. This feature aligns with constructivist learning theories, allowing novices to grasp complex concepts with interactive assistance. However, ensuring the AI's precision and addressing privacy concerns remain critical challenges to address. DevMind's Code Review and Feedback feature promotes peer collaboration and aligns with social constructivism, creating a supportive learning community. The Cloud-Based IDE facilitates accessibility and collaboration across devices and locations, embracing ubiquitous learning principles. However, challenges like AI proficiency and privacy must be addressed. Future improvements could include real-time collaboration and extending the AI mentor's capabilities to multiple programming languages.

Prior to the development of DevMind, the team conducted a comprehensive survey to gather essential insights for shaping the innovative programming platform. To achieve this, randomly selected undergraduate IT students are engaged and administered a survey designed to assess the challenges novice programmers encounter when using various programming environments. This survey served as a foundational step, providing invaluable data to inform the development of the upcoming product. The subsequent section outlines how the research findings and insights from the literature have guided the creation of DevMind, showcasing the relevance and significance of the investigation in shaping this groundbreaking application.

In the pre-development survey, as illustrated in below figure4, unearthed significant challenges that novice programmers confront when transitioning to advanced Integrated Development Environments (IDEs) such as DevMind.Anoteworthy 28.6% of respondents struggled with a pronounced lack of confidence in their programming abilities, underscoring the common doubt beginners have, particularly when tackling intricate coding tasks. Additionally, a significant barrier to effective learning was created by 15.9% of users having difficulty understanding basic coding principles. Collaborative learning's significance in coding practice became evident, with 23.8% of respondents facing difficulties in project collaboration, especially in the context of code review and feedback. Furthermore, 19% reported struggles with debugging and error handling, emphasizing the pivotal role that DevMind's AI-based Virtual Mentor can play in swiftly identifying and resolving coding errors.

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Moreover, the survey illuminated the challenges of integrating the AI-based Virtual Mentor, with 12.7% of users encountering initial apprehension and potential integration issues. These insights have been instrumental in moldingDevMind to effectively address these challenges, creating a nurturing and proficient learning environment tailored to novice programmers' needs.
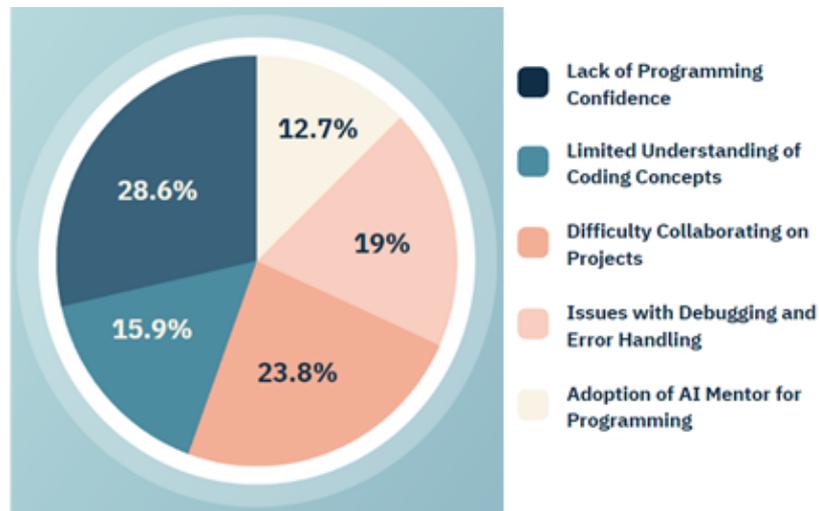
Fig 4: Result of the survey conducted before the development of DevMind

Incorporating the valuable insights gleaned from the pre-development survey and aligning them with the principles of effective programming education, embarked on a journey to create DevMind, an online IDE that not only addresses the challenges novice programmers face but also empowers them to excel in their coding endeavors. The symbiotic relationship between research and innovation is evident in DevMind's design, where every feature and aspect has been carefully crafted to cater to the needs and aspirations of budding programmers. As move forward, committed to refining and expanding DevMind based on user feedback and emerging trends in programming education is remained. The mission is to continue providing a supportive, dynamic, and AI-enhanced learning environment that propels noviceprogrammers toward greater confidence and competence in the world of coding. With DevMind, the future of programming education is indeed brighter, and excited to be at the forefront of this transformative journey.

5.   Conclusion

DevMind is an innovative platform designed to empower novice JavaScript programmers by offering a tailored and transformative learning experience. It bridges the gap between theory and practice, focusing on imparting coding skills and fostering best practices. This platform caters to aspiring JavaScript enthusiasts with limited prior knowledge and integrates various tools to create a comprehensive and supportive learning environment. Notably, it features an AI-based Virtual Mentor that provides real-time guidance and solutions, promoting self-directed learning. DevMind also promotes collaboration through its Code Review and Feedback feature, nurturing a sense of community and shared growth among learners. Its Cloud-Based IDE ensures accessibility and adaptability, enabling learners to engage with coding projects across different devices and locations, redefining traditional learning boundaries for a personalized journey.

While DevMind has made significant strides in aiding novice programmers, it has recognized the importance of addressing certain gaps to enhance its impact and accessibility. There's the potential to expand DevMind's scope by supporting a broader range of programming languages beyond its current focus on JavaScript. This expansion would involve creating tailored content and exercises for languages like Python, Java, and more, catering to a diverse audience of learners. Additionally, gamification elements hold the potential to make the learning experience more engaging, motivating users to excel in their coding endeavors. In the future, it is intended to introduce gamified challenges, achievements, and leaderboards within DevMind. Furthermore, content expansion is on the horizon, with plans to offer a rich variety of resources, including tutorials, video

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lessons, and interactive demos, accommodating various learning styles. And also committed to establishing clear feedback mechanisms within the platform, valuing user input to drive continuous improvement. These initiatives collectively aim to make DevMind a more versatile, engaging, sustainable, and user-centric educational programming environment.

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