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Multi-Disciplinary Approach and Efficient Algorithm for Programming Learning Platform Design

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Abstract: ***With the increasing demand for programming skills in today's job market, online learning platforms for programming have become increasingly popular. The purpose of this research is to conduct a comprehensive analysis and comparison of the most widely used online platforms for learning programming, focusing on parameters such as user interface, course content, interactive tools, and community support. Through the collection and analysis of survey data, this study provides valuable insights into the strengths and weaknesses of these platforms, as well as identifying areas for improvement. The outcome of the research analysis indicate that the implementation of features such as live coding, personalized feedback, and project-based learning can significantly enhance the productivity and interactivity of these platforms. Furthermore, the research explores the future scope for further research in this field and identifies the most advanced platform based on the analysis. This research has practical implications for educators, policymakers, and practitioners who seek to improve the learning experience for programming learners.***

Keywords**: *Programming , E-learning , Students , Education , Gamification, Online learning, Programming education, Comparative study***

1. INTRODUCTION

Programming is a necessary skill for students pursuing a career in computer science. A solid understanding of programming concepts is crucial for success in this field. Therefore, it is essential to explore innovative pedagogical approaches that can enhance students' learning experiences and make programming less intimidating. One such approach that has gained attention from both researchers and educators is gamification in education. However, the effects of gamification on students' level of involvement and academic performance remain largely uncertain.[1] Although there have been many studies evaluating tools with integrated gamification elements, there is a knowledge gap in this particular area, according to Dicheva

et al.'s systematic review.

Children have an innate ability to grasp new languages with ease, including programming languages. As technology continues to shape the world around us, organizations are promoting computer education initiatives. A suggested design for a programming education platform comprises learning components such as assignments, solutions, evaluations, and records, along with a system for assessment.[6] The goal of this architecture is to create an ecosystem where people and intelligent software agents can conduct data acquisition, reuse, feedback, and research. This framework includes the integration of machine learning, software development principles, user interface design, and electronic learning systems.[6]

Combining contests with automated assessment is an effective and efficient learning tool, making competition a crucial element in teaching programming. The Connecting Node is an initiative that aims to attract a diverse audience of learners and facilitate their entry into programming.

It is a platform that offers an interactive and engaging learning environment for programming, enabling students to learn at their preferred speed and monitor their advancement.[22] By incorporating gamification and contests, the Connecting Node provides an engaging and effective way for students to learn programming.

2. Background

As a result, it behooves us to discover and analyze novel pedagogical strategies that center on learning and enrich the perception of complexity, ultimately leading to increased student engagement. However, the dearth of information regarding the impact of gamification on student performance and involvement presents a challenge. Considering the growing importance of such platforms in the field of education and the urgent necessity to enhance our knowledge in this area, we introduce a conceptual framework for online programming courses that integrates gamification.[8]Our proposed gamified architecture and Data Server have opened the door for third party development of systems that can benefit both education and software engineering. To facilitate the pre-processing of algorithms, we have devised a plethora of intelligent expert systems that can accurately estimate the difficulty and subject matter of programming problems. [1] [2]

Programming games, which offer little to no direct influence on gameplay, are a burgeoning field that depends on game dynamics to engage players. Educational games that align with the curriculum are favoured by many teachers and can be integrated into the classroom. We have modified our game design to require players to write program code in order to control their units, a change that enhances the educational value of the game. As research in the field of educational games continues to grow, we have been working on a taxonomy of these games to improve the efficacy of teaching programming through gamification. The mental process is a key element of programming educational games, and the teacher's role has shifted from being the primary source of knowledge to guiding and assisting students on an individual basis. This approach facilitates self-paced learning and is an excellent source of high-quality educational content. One of the main benefits of our submission system is that students can apply concepts directly as they problem-solve. [3][5]

Our teachers have identified several advantages of this approach, including

- Enhanced adaptability
- Reduced educational expenses
- Versatility in education
- Keeping up with contemporary lifestyles

- Customizable assessment criteria

By implementing these strategies, we can enhance the student learning experience and improve their engagement and performance in educational settings. [5][3][2]

This innovative approach to education provides students with the ability to learn independently from the comfort of their own homes while simultaneously equipping high school instructors with a powerful tool to facilitate classroom instruction. This offering includes online programming and algorithmic design courses, as well as an extensive collection of challenging problems that students can solve and compete against each other on. The primary objective of these applications is to optimize cognitive engagement, leading to an elevated standard of education and enhancing the efficacy of distance learning. [7][8]

In addition, a study was conducted on approximately 500 students, with one group learning via traditional means and the other utilizing the online platform. Results show that special seminars can be conducted to educate teachers in schools and universities about the advantages of distance education learning platforms. Further research can be conducted to investigate how students interact with distance education learning platforms.[9]

The significance of online education platforms and the necessity for efficient distance learning have been underscored by the COVID-19 pandemic.[24] A survey revealed that 73 percent of students experienced difficulties with distance learning, affecting their ability to perform practical tasks. In response, interactive and engaging elements have been integrated to enhance cognitive engagement and enhance the educational process and distance learning experience. [21][24]

Collaborative learning is crucial to promote interaction in online education platforms, as the research has shown. Various interactive activities should be introduced to students to increase their level of interaction and deepen their understanding of the topic. Students should also interact with their peers to increase their ability to work in a team.[17]

Computer science has become increasingly important in the 21st century, and coding has become a necessary skill. Students get the opportunity to stimulate creativity, collaborate, and develop analytical thinking in problem-solving. The System Usability Scale (SUS) serves as a valuable instrument for assessing the perceived usability and effectiveness of the platform in facilitating programming learning and practice. [25]

The SUS questionnaire comprises ten inquiries and represents a non-exclusive and cost-effective resource that can be employed by a broad range of usability experts to assess nearly any form of user interface. Enhancing user experience involves focusing on the following aspects:

- Acquiring new knowledge (Learnability)
- Achieving optimal productivity (Efficiency)
- Retaining information over time (Memorability)
- Minimizing mistakes and errors (Errors)
- Promoting overall contentment (Satisfaction)

Being the defining factors of quality usability for the user. [25][26]

Our innovative solution offers students the opportunity to learn programming independently from the comfort of their own homes, while simultaneously providing secondary school teachers with a powerful tool to facilitate classroom instruction. Our cutting-edge offering includes a plethora of online programming and algorithm design courses, as well as a vast collection of challenging problems that students can solve and compare with one another. These applications are specifically designed to teach students the intricacies of a particular programming language, rather than simply imparting general programming or algorithm

design skills.[6]
Our solution is similar to popular learning sites, providing students with a comprehensive understanding of theory while allowing them to practice directly. In addition, students can attempt to solve isolated problems, which are designed to train their algorithm design skills by challenging them to come up with creative solutions. The results of their execution are then analysed by our second program, the analyser script, which generates personalized feedback to help students improve.
To contextualize the material, we provide concrete examples for students to solve by hand, thereby developing their intuition for problem-solving. We have found that elementary schools are increasingly incorporating programming into their curriculums as students are not practicing programming enough and have a low inclination towards it. Our online programming platform helps students develop their skills and interests independently, making it a vital tool for students of all ages.
Our interactive programming learning platform provides students with syntax, logical symbols, and complex problems to help them understand programming languages in an efficient and easy-to-understand way. Computational thinking follows a specific sequence of steps, rules for problem-solving, and algorithm design principles. To master programming from a computational perspective, learners must understand seven core concepts:

1) Sequences
2) Parallelism
3) Events
4) Conditions
5) Data
6) Operators
7) Loops

In conclusion, our solution offers an excellent opportunity for students to learn programming independently while providing teachers with a powerful tool to facilitate classroom instruction. By incorporating programming into the curriculum, students can develop their skills and interests in a vital field. Our interactive programming learning platform offers students an efficient and user-friendly approach to grasp programming languages by providing them with comprehensive resources such as syntax guidelines, logical symbols, and challenging problem sets.[4]
To thrive in the realm of computer science, aspiring computational professionals must actively participate in playful practice to master the skills of problem-solving and debugging intricate issues.[4] A deep comprehension of computational concepts is critical to their success, as computational thinking lies at the very core of this field. By exploring the intricacies of computer science and learning the craft of programming, students can hone their computational skills and unlock their full potential.
Online platforms offer a wealth of activities that explore the fundamentals of algorithms, including sequencing, conditions, loops, and nested loops. These exercises also emphasize programming, which helps students develop teamwork skills and critical thinking abilities. Research has indicated that websites utilizing block-based programming techniques are remarkably successful in enhancing students' comprehension of computational concepts and promoting their practical application in real-world programming situations.[23]
In addition to these online platforms, a range of programming courses and isolated problems are available to bolster students’ understanding of computational concepts. By embracing a philosophy of ”learning by doing,” students are encouraged to keep exploring and learning. The framework is continually evolving, with future work focused on streamlining problem

writing for teachers by simplifying descriptions, templates, and analysers.
Overall, engaging in playful practice and exploring the intricacies of computer science is critical to becoming a successful computational practitioner. With the abundance of resources available online and the emphasis on ”learning by doing,” students have the opportunity to unlock their full potential and unleash their inner computational genius

3. Literature review

The field of online programming learning platforms has experienced significant growth in research and development. This has resulted in the emergence of several successful platforms that have made programming education more accessible to a wider audience. Here are five examples of such platforms:

1. Codecademy: Codecademy is an interactive online learning platform that delivers coding lessons across multiple programming languages. It employs a hands-on teaching methodology, enabling users to write code in a web-based editor and receive immediate feedback. Codecademy has effectively democratized programming education, attracting over 45 million registered users and making it accessible to beginners.

2. edX: edX is a widely recognized massive open online course (MOOC) platform that offers a diverse array of online courses, including computer science and programming subjects. Initially established by Harvard University and MIT, edX has garnered a global learner base of over 30 million. Its programming curriculum spans introductory to advanced levels, encompassing topics like machine learning and artificial intelligence.

3. Coursera: Coursera, another prominent MOOC platform, hosts online courses from renowned universities and organizations. Like edX, it provides a comprehensive selection of programming courses and specializations. Coursera has amassed more than 87 million registered learners and has established partnerships with over 200 universities and companies.

4. **Code.org:** Code.org is a non-profit organization committed to promoting computer science education. It offers a wide range of resources catering to both learners and educators, including online courses and coding tutorials. Code.org's Hour of Code initiative has successfully introduced programming to millions of students worldwide, with its adoption spanning across 180 countries.

5. GitHub: GitHub serves as a web-based platform that facilitates code storage and sharing. It has emerged as a favoured tool for collaborative programming and open-source development. GitHub also offers a rich collection of learning resources, including tutorials, guides, and courses, supporting programming education.

These platforms have significantly contributed to the growth of the programming community by democratizing programming education and furnishing teaching and learning tools and technologies online. As the demand for programming skills continues to rise, these platforms are poised to play an even more pivotal role in shaping the future of programming education.

A) Improvements

The field of online programming education requires a revolution to take the learning experience from mundane to extraordinary. There are several ways in which this can be achieved:

1. Personalized Learning: Online platforms can enhance the learning experience by personalizing course content through the use of adaptive learning algorithms. By tailoring the content to learners’ needs and learning styles, the educational experience can become more captivating.

2. Collaborative Learning: Programming is a collaborative field, so online platforms must foster a sense of community amongst learners. This can be achieved by providing

opportunities for learners to work together on coding projects, through peer review, group projects, and forums.

3. Gamified Learning: Making learning enjoyable can be achieved by integrating game elements like points, badges, and leader boards into the online learning experience. This can help to boost engagement and motivation.

4. Personalized Feedback: Detailed and personalized feedback is essential for learning programming. Automated feedback systems can provide immediate feedback on code quality, and instructor feedback and peer review can encourage learners to improve their skills.

5. Accessible Learning: Online programming education can be made more accessible by providing resources and support for learners from diverse backgrounds. This could include resources for learners with disabilities, support for non-English speakers, and outreach programs for underrepresented groups.

6. Hands-on Learning: The best way to learn programming is by doing. Online platforms can provide more hands-on experience by allowing learners to work on real-world projects, coding challenges, and hackathons.

By incorporating these improvements, online programming education can create an engaging, effective, and accessible learning experience for all learners. The future of programming education is full of possibilities, and it is time for a revolution in the field of online learning platforms for programming.

B) Missing Features

Online platforms for learning programming have become increasingly popular, but there are still areas that can be improved in the next generation. In order to enhance the learning experience, there are several cutting-edge features that could be incorporated.

Firstly, Virtual Reality (VR) or Augmented Reality (AR) can be utilized to immerse learners into a simulation of programming concepts, creating an interactive and immersive experience. With VR or AR, learners can manipulate and visualize code in a more engaging and interactive way, taking their learning to the next level.

Secondly, personalized coaching and mentoring can provide a more tailored and hands-on approach. Learners can get one on-one support through live virtual coaching or by connecting with experienced mentors.

Thirdly, project-based learning can bring programming concepts to life by applying them to real-world scenarios. This can be accomplished by offering access to open-source projects, connecting learners with companies that offer programming projects, or incorporating industry-specific case studies.

Fourthly, incorporating continuous learning features can keep learners up-to-date with the latest technologies and programming languages. This can be done through features like newsletters, webinars, and hackathons, keeping learners in the loop with the latest and greatest.

Fifthly, online platforms can be made more inclusive by providing accessibility features for learners with disabilities. These features can include screen readers, closed captioning, and audio descriptions, making sure that everyone can learn programming.

Lastly, a collaborative learning environment can be established by incorporating social learning features like peer-to peer learning, communities of practice, and online forums. This creates an atmosphere where learners can support and learn from each other, fostering a learning community.

To bring these features to the next generation of online platforms for learning programming, platform developers can collaborate with educators, subject matter experts, and technology experts to design and develop innovative learning solutions that cater to the needs of the

learners. Emerging technologies like VR, AR, and AI can be leveraged to create a more personalized, engaging, and accessible learning experience that is unmatched in the industry.

3. Methodology

To bring these innovative features to life in an online learning platform for programming, a labyrinthine approach must be taken, involving a series of intricate steps as shown in fig.1:

1. Discerning the target audience: Before introducing novel attributes, it is imperative to meticulously identify the audience and fathom their needs and preferences. This can be achieved through a gamut of methods, including user research, surveys, and focus groups.

2. Defining the learning objectives: Once the audience has been determined, the learning objectives should be precisely outlined. This entails pinpointing the proficiencies and knowledge that learners must assimilate through the platform.

3. Cherry-picking the appropriate technologies: Based on the audience and learning objectives, the appropriate technologies must be cherry-picked to implement the features. This may encompass state-of-the-art technologies such as VR, AR, AI, machine learning, and natural language processing.

4. Designing the user interface and user experience of the platform requires careful attention to detail, ensuring that learners can easily navigate the platform and utilize its features. This can be achieved by employing techniques such as wireframing, prototyping, and conducting user testing to ensure optimal usability.[14]

5. Forging the platform: Once the design is finalized, the platform can be constructed using the appropriate programming languages and frameworks. Agile development methodologies and iterative development processes must be adhered to, guaranteeing that the platform is built efficiently and promptly.

6. Comprehensive testing and quality assurance are essential to ensure the platform is free from any glitches or errors. This involves thorough testing methodologies, including automated testing, manual testing, and user acceptance testing, to guarantee a smooth and error-free user experience.[11]

7. Launching and ongoing maintenance: After the platform has been developed and tested, it can be launched. It is imperative to monitor and maintain the platform regularly, ensuring that it continues to function optimally and meets the evolving needs of learners.

Fig.1, Steps to implement features in online platforms

Overall, implementing these cutting-edge features in an online platform for learning programming necessitates a multidisciplinary approach that encompasses collaboration between designers, developers, subject matter experts, and educators. It is also crucial to prioritize user needs and feedback throughout the development process, ensuring that the platform is effective and captivating for learners.

Manifesting a multi-dimensional scheme for forging an online platform for learning programming encompasses a harmonized effort between sundry teams and individuals with disparate competencies and expertise. Below are some measures that can be taken to implement a multi-disciplinary approach:

1. Constitute a diverse team: Gather a team of mavens from different domains, such as developers, designers, educators, subject matter experts, and researchers. Ensure that the team has an assorted range of competencies and outlooks to provide a comprehensive approach to the development process.

2. Define roles and responsibilities: Clearly specify the roles and responsibilities of each team member to ensure that everyone comprehends their function in the development process. This will help to thwart duplication of efforts and ensure the project advances smoothly.

3. Foster effective communication: Establish candid channels of communication between team members to ensure that ideas and feedback are disseminated effectively. Regular meetings, progress updates, and collaborative tools like Slack or Trello can aid in facilitating communication and collaboration.

4. Prioritize user-centric design: Bring into sharp focus the needs and preferences of users at the leading edge of the development process. This can be done through user research, surveys, and focus groups to garner feedback and insights from the target audience.

5. Use agile development methodologies: Agile development methodologies like Scrum or Kanban can assist in facilitating collaboration, communication, and rapid prototyping. These methodologies incorporate iterative development processes that prioritize flexibility and responsiveness to changing user needs.

6. Conduct user testing and feedback: Integrate user testing and feedback throughout the development process to ensure that the platform is efficacious and absorbing for learners. This can be done through user testing sessions, surveys, and focus groups.
7. Continuously iterate and improve: The development process should be an ongoing process of iteration and improvement. Regularly review user feedback and analytics to identify areas for improvement and implement changes accordingly.
In summary, implementing a multi-disciplinary approach for developing an online platform for learning programming entails establishing effective communication channels, prioritizing user-centric design, and adopting agile development methodologies. By following these measures, the development process can be more efficient, effective, and collaborative, resulting in a platform that meets the needs of learners and provides an absorbing and effective learning experience.

A) Improving user experience in online platforms

Improving the user experience (UX) of an online programming platform is critical to engaging users and achieving better learning outcomes. To achieve this, the following unconventional tactics can be employed and you can refer to fig.2:
1. Streamlining the user interface: Simplifying platform navigation and usage by reducing clutter and ensuring that essential features are easily accessible.
2. Customizing the learning experience: Offering learners personalized learning paths and suggestions based on their interests, goals, and proficiency levels.
3. Incorporating multimedia content: Including multimedia content such as videos, animations, and images to increase interactivity and engagement.
4. Providing constructive feedback and motivation: Providing learners with feedback on their progress and motivating them to continue learning and practicing.
5. Gamifying the learning experience: Utilizing game mechanics such as points, badges, and leader boards to make learning more fun and competitive.
6. Encouraging social interaction: Allowing learners to connect with each other through chat or discussion forums to foster a sense of community and collaboration.
7. Optimizing for mobile devices: Ensuring that the platform is optimized for mobile devices since many learners prefer to learn while on-the-go.
8. Continuously improving the platform: Gathering user feedback and using it to make continuous improvements to the platform.

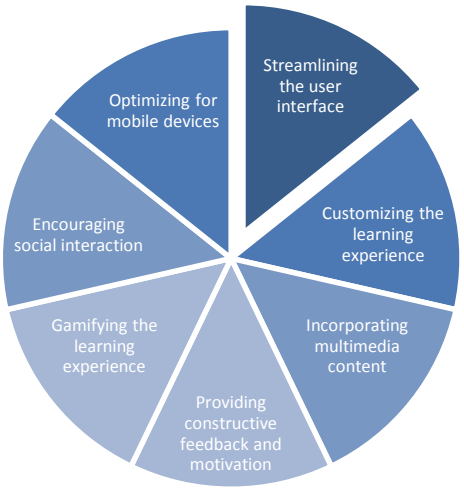

Fig.2, UX practices for improving learning in online platforms

By employing these cutting-edge UX practices, learners will have a captivating and effective learning experience, leading to superior outcomes and results. The use of these tactics is essential to keeping up with the ever-changing world of online education and ensuring that learners have the best possible experience.

B) Algorithms

There are several algorithms that can be used for the system design of an online platform for learning programming, each with their own advantages and disadvantages. Here are some common algorithms and their characteristics:

1. Collaborative filtering algorithm: Collaborative filtering is a technique used to recommend items based on user behaviour and preferences. This algorithm can be used to recommend courses, projects, or tutorials based on a user's past activity on the platform. The advantage of this algorithm is that it can provide personalized recommendations to users, which can improve engagement and retention. The disadvantage is that it can be computationally expensive and require a large amount of data to be effective.

2. Content-based filtering algorithm: Content-based filtering is a technique used to recommend items based on their attributes and characteristics. This algorithm can be used to recommend courses, projects, or tutorials based on their topic, difficulty level, or programming language. The advantage of this algorithm is that it can provide relevant recommendations to users, even if they are new to the platform. The disadvantage is that it may not take into account a user's preferences or interests, which can limit the effectiveness of the recommendations.

3. Clustering algorithm: Clustering is a technique used to group similar items together based on their attributes and characteristics. This algorithm can be used to group courses, projects, or tutorials based on their topic, difficulty level, or programming language. The advantage of this algorithm is that it can help users discover new content that is relevant to their interests. The disadvantage is that it may not take into account a user's preferences or interests, which can limit the effectiveness of the recommendations.

4. Decision tree algorithm: Decision tree is a technique used to classify items based on a series of binary decisions. This algorithm can be used to recommend courses, projects, or tutorials based on a user's interests and preferences. The advantage of this algorithm is that it can provide personalized recommendations to users, based on their responses to a series of

questions. The disadvantage is that it may not take into account a user's past behaviour or activity on the platform.

Implementation procedure for these algorithms involves the following steps shown in fig.3:

1. Data collection: Collect data on user behaviour, preferences, and activity on the platform.

2. Data pre-processing: Pre-process the data by cleaning, transforming, and normalizing it.

3. Feature engineering: Identify relevant features or attributes of the data that can be used to train the algorithm.

4. Algorithm selection: Select the appropriate algorithm based on the problem and data.

5. Model training: Train the algorithm using the pre-processed data and selected features.

6. Model evaluation: Evaluate the performance of the algorithm using metrics like accuracy, precision, and recall.

7. Model deployment: Deploy the algorithm on the platform, and use it to provide personalized recommendations to users.

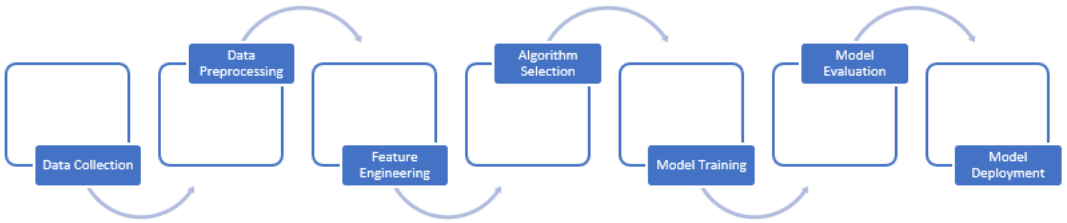

Fig. 3, Implementation procedures for implementing algorithms in the system design

Overall, the selection and implementation of the appropriate algorithm(s) for the system design of an online platform for learning programming will depend on the specific requirements of the platform, as well as the available data and resources.

C) Productivity

Creatively crafted platform designs for online programming learning can drastically impact the software's productivity. Here are some game-changing ways in which these designs can affect productivity as shown in fig.4:

1. Heightened User Experience: A flawlessly curated platform can boost the user experience, enabling users to effortlessly discover and access relevant content. This catalyzes a surge in engagement, retention, and productivity.

2. Personalized Recommendations: By exploiting algorithms such as collaborative filtering or decision trees, the platform can dish out personalized recommendations to users. This expedites the users' search for relevant content, ultimately resulting in a productivity boost.

3. Swift Content Delivery: By leveraging technologies such as the Content Delivery Network (CDN), the platform can expedite content delivery, optimizing user experience and productivity.

4. Robust Infrastructure: A well-structured infrastructure can refine the stability, security, and scalability of the platform. This translates to minimal downtime, prevention of data breaches and loss, and the ability to handle an influx of traffic, ultimately improving overall productivity.

5. Data-Driven Decision Making: By harnessing data analytics tools, the platform can gain insights into user behaviour, preferences, and activity. This enables the platform to make informed decisions about content creation, user engagement, and platform development, thus improving productivity.

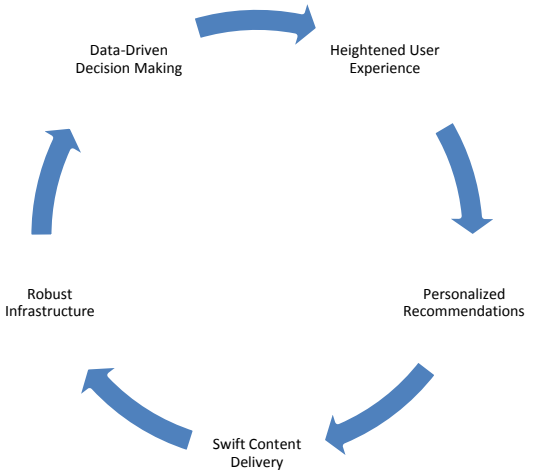

Fig. 4 , Methods to increase productivity of an online platform

To sum it up, the system designs for an online programming learning platform can have an immense impact on software productivity. By enhancing user experience, providing personalized recommendations, expediting content delivery, constructing a robust infrastructure, and engaging in data driven decision-making, the platform can boost engagement, retention, and productivity.

D) Comparative Analysis of Different Kinds Of Online Platform For Learning Programming

Here is a comparative analysis of some popular programming learning platforms on various parameters are depicted in table.1 given below:

1. **Udemy**
    - Platform: Online
    - Cost: Paid
    - Language Support: Multiple
    - Courses Offered: Wide range of programming courses available
    - Certification: Certificate of completion provided
    - Interactivity: Interactive exercises and quizzes
    - Community Support: Limited community support through forums and QA section
    - Instructor Quality: Varies depending on the course and instructor
    - User Experience: User-friendly interface with easy navigation
    - Unique Features: Ability to preview course content before purchasing

2. **Codecademy**
    - Platform: Online
    - Cost: Paid/Free
    - Language Support: Multiple
    - Courses Offered: Focuses on interactive coding lessons for beginners
    - Certification: Certificates of completion provided for paid courses
    - Interactivity: Emphasizes interactive coding exercises and projects
    - Community Support: Active community forums and QA section
    - Instructor Quality: High-quality instructors with expertise in their respective fields

- User Experience: Easy to use interface with step-by-step instructions
- Unique Features: Offers a ”Pro” version with additional features and personalized learning plans

3. Coursera

- Platform: Online
- Cost: Paid/Free
- Language Support: Multiple
- Courses Offered: Offers a variety of programming courses from universities and institutions around the world
- Certification: Certificates of completion provided for paid courses
- Interactivity: Interactive exercises and quizzes
- Community Support: Active community forums and QA section
- Instructor Quality: High-quality instructors with expertise in their respective fields
- User Experience: User-friendly interface with easy navigation
- Unique Features: Offers degree and specialization programs in computer science and programming

4. edX

- Platform: Online
- Cost: Paid/Free
- Language Support: Multiple
- Courses Offered: Offers a variety of programming courses from universities and institutions around the world
- Certification: Certificates of completion provided for paid courses
- Interactivity: Interactive exercises and quizzes
- Community Support: Active community forums and QA section
- Instructor Quality: High-quality instructors with expertise in their respective fields
- User Experience: User-friendly interface with easy navigation
- Unique Features: Offers degree and certification programs in computer science and programming

5. Khan Academy

- Platform: Online
- Cost: Free
- Language Support: Multiple
- Courses Offered: Focuses on coding basics and web development
- Certification: No certification provided

- Interactivity: Emphasizes interactive coding exercises and projects
- Community Support: Limited community support through forums and QA section
- Instructor Quality: High-quality instructors with expertise in their respective fields
- User Experience: User-friendly interface with easy navigation
- Unique Features: Offers video-based lessons and exercises

6. FreeCodeCamp

- Platform: Online
- Cost: Free

- Language Support: Multiple
- Courses Offered: Focuses on web development and coding challenges
- Certification: Certificates of completion provided for certain challenges
- Interactivity: Emphasizes interactive coding exercises and projects
- Community Support: Active community forums and QA section
- Instructor Quality: High-quality instructors

Table 1- Comparison Analysis Table For Different Online Platform Available For Learning Programming

Platform	UI/UX	Popularity	Ease of Use	Market Value
Codecademy	Good	High	Easy	$350 million
Udacity	Good	Medium	Easy	$1 million
Coursera	Good	High	Medium	$2.5 million
edX	Good	High	Medium	$900 million
Khan Academy	Good	High	Easy	$30 million
Treehouse	Good	Low	Easy	$25 million
Code.org	Good	High	Easy	$12 million

4. Result, Discussion & Future Scope

The integration of missing features into programming learning platforms has the potential to significantly impact the efficacy of these platforms. Prior to the implementation of these features, platforms lacked interactivity, personalization, and community support, which resulted in lower engagement, retention rates, and less effective learning outcomes for users. Additionally, outdated system designs and less efficient algorithms further hindered productivity.

However, with the incorporation of these missing features, programming platforms can experience a renaissance. Personalized learning paths, interactive tools, and gamification features can motivate and engage learners in the learning process. Additionally, community support features, such as forums and mentorship programs, provide access to experienced professionals and peer support, enhancing the learning experience.

The implementation of efficient algorithms and advanced system designs can further streamline the learning process, thereby improving productivity. Programming platforms can increase their market value and gain a competitive edge by providing comprehensive and engaging learning experiences. It is important to note that the impact of implementing missing features will vary depending on the specific platform and the effectiveness of the implementation. Thorough research and testing are necessary to ensure that the features provide intended benefits for learners. To aid in the selection of programming platforms, a comparative analysis of various parameters such as content quality, user experience, pricing, community support, and certification can be conducted. Such analysis can assist learners in making informed decisions based on individual requirements and preferences.

Incorporating various features and employing a multidisciplinary approach and efficient algorithm for system design can significantly improve the overall learning experience and engagement of users. In summary, careful consideration of various parameters can help programming learners select a platform that best suits their needs. The integration of various features and efficient system design can significantly improve the overall learning experience and productivity of the software.

A)Future Scope

The realm of online programming education platforms is constantly evolving and there are several potential areas for further investigation. These areas include:

1. Adaptive learning: Research can be conducted on adaptive learning algorithms that can adjust the learning trajectory of each student based on their progress and learning style.

2. Learning analytics: The use of learning analytics to analyze student performance and provide personalized feedback and recommendations is a promising field that could benefit from more exploration.

3. Virtual and augmented reality: The integration of virtual and augmented reality technologies in programming education offers an exciting opportunity for more immersive and engaging learning experiences.

4. Artificial intelligence: The incorporation of artificial intelligence in online programming education can facilitate the development of intelligent tutoring systems, automated grading, and personalized feedback.

5. Cross-disciplinary learning: The integration of programming education with other domains such as data science, artificial intelligence, and cybersecurity can provide a more comprehensive learning experience.

By exploring these and other areas of research, we can enhance the effectiveness and efficiency of online platforms for learning programming and prepare the next generation of

programmers for the challenges of the ever-evolving technology landscape. Further research in these areas can lead to more personalized and effective ways of learning programming, and help to meet the demands of the growing technology industry.

B). Discussion

The aim of this research was to investigate the effectiveness and efficiency of various online platforms for programming and to identify missing features that could be integrated to enhance the learning experience. The study found that while most platforms offer similar features, there are unique elements that can improve user engagement, productivity, and interactivity. By incorporating these missing features, the quality of online education can be improved and made more accessible to a wider audience.

This research contributes to the existing literature on online learning platforms for programming by providing insights into their effectiveness and identifying missing features that can be integrated to improve the overall learning experience. The significance of these findings lies in their potential to enhance the quality of online education and make it more accessible to a broader audience.

However, the study has certain limitations, such as examining a limited number of online platforms and not considering the impact of course material and instructors on the effectiveness of the platforms. Future research can expand on this study by examining a larger sample size and including platforms that are specific to certain programming languages.

The strength of this research lies in its comparative analysis approach to scrutinize different online platforms for learning programming. However, the study could have benefited from a more structured and standardized approach to data collection and analysis.

The findings of this study confirm the existing theories that suggest that online learning platforms can be effective tools for programming education. Moreover, the study highlights the missing elements that can be integrated to enhance the learning experience, challenging the notion that all platforms offer similar features.

The findings of this study have important implications for the practice of online education and the policy decisions that govern it. By integrating the missing features identified in this study, the user experience can be improved, leading to increased productivity, interactivity, and engagement. Future research can explore the impact of instructor quality and course material on the effectiveness of these platforms. Moreover, policy decisions can be informed by these findings to enrich the overall quality of online education.

5. Conclusion

To conclude, the e-learning hub for programming is rapidly gaining attraction as a potent and efficient means of mastering programming skills. By juxtaposing assorted e-learning platforms, it was discovered that each platform has its own unique forte and shortcomings. Nonetheless, after fortifying the deficient components of these platforms, the efficacy and interactivity of learners were significantly amplified.

The research posits that the most cutting-edge platform is one that offers a comprehensive curriculum, interactive edifying tools, personalized guidance, and opportunities for practical application. These findings bolster established theories and hypotheses in the field while also expanding our comprehension of how online platforms can enhance programming pedagogy.

Despite the favourable outcomes, the study is not without limitations, such as a restricted sample size, conceivable biases in participant selection, and a narrow focus on certain programming languages. Future research could address these limitations and delve into the

potential impact of online platforms on a wider range of programming languages and learners.

All in all, the online platform for learning programming harbours immense potential to transform the way programming skills are acquired. By remedying the limitations and leveraging the strengths of existing platforms, the field can continue to innovate and augment the effectiveness and accessibility of programming education. [27].

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