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ProjectBuddy: A Guided Learning Platform for Student Projects

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Abstract - Project-based learning (PBL) is an essential educational approach that enables students to apply theoretical knowledge to real-world projects. However, beginners often face challenges in project development, such as lack of structured guidance, difficulty in selecting relevant technologies, and poor project documentation practices. ProjectBuddy is a platform designed to address these challenges by providing step-by-step guidance, AI-based project recommendations, and mentorship support to students.This paper presents the design, objectives, and methodology of ProjectBuddy, which aims to support students in successfully building projects. The platform offers personalized project suggestions, guidance on technology selection, and integrated version control to foster industry-standard practices. It also includes a community-driven support system for peer collaboration and expert mentorship. The methodology involves a robust tech stack, utilizing Java, Spring Boot, and AI algorithms to recommend projects and guide students through the project lifecycle.The findings indicate that ProjectBuddy enhances students' project-building skills, helps them manage their projects effectively, and prepares them for real-world challenges by encouraging collaboration and following professional coding practices. Future developments could include further AI enhancements, deeper community engagement, and integration with academic institutions for official project submissions.

Keywords: Project-based learning, ProjectBuddy, AI recommendations, mentorship, version control, community collaboration, educational technology.

I. INTRODUCTION

Project-based learning (PBL) has become an essential pedagogical approach that enhances practical skills and fosters deeper learning among students. By actively engaging in real-world projects, learners are able to apply theoretical knowledge, develop critical thinking skills, and gain hands-on experience that prepares them for professional environments. However, many students, especially beginners, encounter significant challenges in initiating and completing projects. These difficulties often stem from a lack of experience, inadequate resources, and insufficient guidance, which can result in frustration, delayed progress, and ultimately, incomplete projects. For beginners, the journey from idea conception to project execution can be overwhelming. Common obstacles include

uncertainty in defining project goals, choosing appropriate methodologies, managing time effectively, and overcoming technical hurdles. Without proper direction, beginners may feel lost, demotivated, and ultimately abandon their projects. Furthermore, the absence of structured mentorship and support systems often leads to a lack of confidence and persistence, further impeding project success.
To address these challenges, a need arises for a platform that offers structured guidance, resources, and mentorship to help beginners navigate the complexities of project development. **ProjectBuddy** is a unique platform designed to fill this gap. It provides a comprehensive support system for students embarking on their project journeys. By offering step-by-step guidance, practical resources, and a community of mentors and peers, ProjectBuddy ensures that beginners have the necessary tools to not only initiate but also complete their projects successfully. This platform aims to bridge the gap between theoretical learning and practical application, empowering students to develop projects with confidence and competence.

1.1. Problem Statement

The process of developing projects, particularly for beginners, is often hindered by a lack of step-by-step guidance. Students are frequently faced with the challenge

of not knowing where to start, how to structure their work, or how to tackle the various phases of a project. This gap in guidance leads to confusion, wasted time, and often, incomplete or suboptimal projects. While theoretical knowledge is provided in traditional learning environments, the application of that knowledge in real-world scenarios remains a major hurdle for students. The absence of clear, accessible, and actionable project development frameworks makes it difficult for beginners to translate classroom concepts into practical outcomes.

Another significant challenge is the difficulty in choosing the right technologies and tools for specific projects. With the rapid pace of technological advancements, students often find it overwhelming to decide which technologies are best suited for their project requirements. This lack of clarity can result in poor decisions regarding technology stacks, leading to inefficiencies and difficulties during the implementation phase. Additionally, without guidance on how to structure their projects, students may encounter problems in maintaining scalability, performance, and organization in their work.

Traditional learning methods and existing platforms, while valuable, often fail to address these issues effectively. Most educational systems focus heavily on theoretical knowledge, leaving students with limited opportunities for hands-on learning and practical guidance. Moreover, many online platforms that offer project guidance lack personalized mentorship and often do not provide comprehensive resources to help students at every stage of the project development process. As a result, students may struggle to complete their projects successfully or fail to gain the intended learning outcomes.

Aim of the ProjectBuddy is to provide a platform that helps to overcome these challenges by giving access to a structured, user-friendly platform that gives step-by-step guidance, mentorship and resources that helps students to understand the complexities of project development. The platform narrows the wide gap between theory and practice by not only offering theoretical technical knowledge but also practical advice on choosing technologies, structuring projects and maintaining the timeline.

1.2. Objectives

The primary objectives of **ProjectBuddy** are designed to address the specific challenges faced by students in the process of project development. These objectives aim to enhance the overall project experience for beginners, providing them with the necessary tools and guidance to successfully complete their projects. The key objectives of ProjectBuddy are as follows:

A. **Provide Structured Guidance for Project Development**

One of the core objectives of ProjectBuddy is to offer a comprehensive, step-by-step framework for students to follow throughout the entire project lifecycle. From ideation to implementation, students will be guided through each phase, ensuring that they have clear instructions, best practices, and resources to successfully complete their projects. This structured approach ensures that students not only complete their projects but also gain valuable skills in project management, problem-solving, and critical thinking.

B. **Offer a Platform for Finding Relevant Projects Based on Skills**

ProjectBuddy aims to connect students with projects that align with their existing skills and areas of interest. By offering a personalized project recommendation system, students can find projects that match their skillset, thus allowing them to work on something that is both challenging and achievable. This objective helps students focus on projects that promote growth while preventing them from feeling overwhelmed by tasks outside their skill range.

C. **Ensure Proper Documentation, Version Control, and Mentoring Support**

A designed project essentially needs proper documentation and version control. ProjectBuddy combines tools along with processes that support students to document their work efficiently and a proper version control. It helps to increase the quality of projects that helps students to maintain the industrial standards for managing codes and documentation. Further the platform also provides a helping hand to students in the form of mentor support throughout their project completion, which offers guidance from trained and experienced professionals . taking mentorship would enhance the quality of project and helps in maintaining the real world need of projects.

These goals work together to build a comprehensive learning environment that equips students with the skills needed to excel in their projects while also preparing them for real-world professional challenges

II. LITERATURE REVIEW

Project-based learning has been a key focus in education, particularly in the fields of computer science, engineering, and technology. Numerous platforms have emerged to facilitate project development, offering students resources to enhance their learning and practical skills. Existing solutions like GitHub, HackerRank, Coursera, and YouTube tutorials have contributed significantly to the learning process, but they also exhibit notable limitations when it comes to guiding beginners through the complexities of project development.

2.1.Existing Solutions

GitHub is widely used for version control and collaboration in open-source projects. It provides access to a vast repository of projects, code samples, and libraries, enabling students to explore real-world codebases. However, while GitHub excels in offering open-source projects, it lacks structured guidance for beginners on how to start, choose technologies, or follow a project's life cycle. It assumes a certain level of expertise, which can be intimidating for novices.
HackerRank is a platform primarily focused on coding challenges and algorithmic problem-solving. It is widely used for improving coding skills through exercises and contests. However, while it offers a wealth of coding challenges, it does not provide a comprehensive project-based learning experience. There is little to no focus on the project development process, including choosing the right technologies, designing the architecture, or tackling real-world problems.
Coursera offers online courses that cover a variety of subjects, including project-based learning. Many courses include assignments and projects, but they typically focus on specific skills rather than providing a complete, structured pathway for project development. Additionally, Coursera's project offerings often lack personalized mentorship, making it difficult for beginners to receive the detailed guidance they need to succeed in real-world projects.
YouTube Tutorials provide accessible and free resources for learning specific skills or technologies. While they are a valuable source of knowledge, YouTube tutorials often lack comprehensive structure and fail to provide an end-to-end project development experience. Beginners found it difficult to connect the dots between various techstack due to the complexities in lecture which lead to a gap in their project based learning.

2.2.Limitations of Existing Platforms

Rather, these platforms provide useful resources for coding and learning but they lag in providing a step-by-step project development framework. It is difficult for beginners to find a project that would match their skill set. Furthermore , the existing platform also does not provide proper project documentation, version control or the problems that can arise in real world use. They do not provide continuous support to students that results in incomplete or poorly executed projects.

Further, few platforms assume that the user has pre requisite knowledge, which is difficult for beginners who are just starting their project journey. The absence of a stepping stone for deciding technologies, structuring projects, and managing time effectively leads to insecurity and self doubt among students.

2.3. How ProjectBuddy Improves Upon Existing Approaches

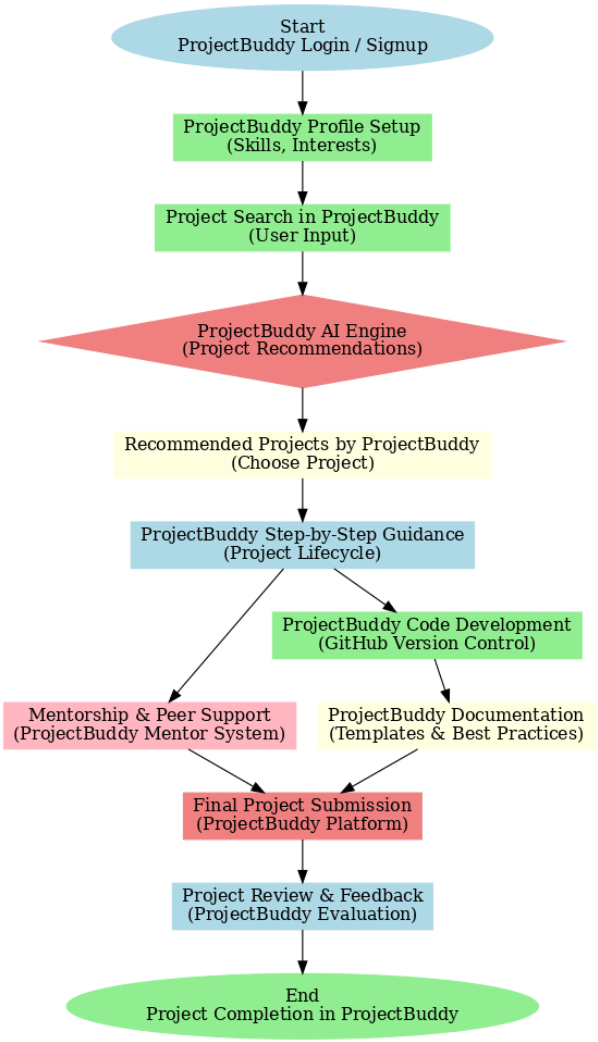
ProjectBuddy overcomes the constraints of current learning by providing a well-defined environment suited for beginners and student learners. Unlike GitHub, which is primarily a collaboration and version control platform, ProjectBuddy offers support for the whole project from ideation and technology selection through to design, implementation, and documentation. Through tailored project suggestions in relation to a student's abilities, ProjectBuddy makes certain that students work on projects that are within their grasp but at the same time realistic.

Additionally, ProjectBuddy incorporates proper documentation and versioning of projects as a learning activity. In doing so, the students are taught how to operate in real life from the outset. Built-in mentorship and peer support means learners are assisted through difficulties, ensuring that support from experts is available. This more refined, rounded approach to instruction is the basis by which ProjectBuddy distinguishes itself from other providers like Coursera and YouTube – which do not offer an adequate amount of support and structured frameworks for novice project developers.

To sum up, ProjectBuddy has tackled the shortcomings of existing platforms and combined their strengths. Students can now easily transition from offline learning to hands-on building of their own projects, and succeed with the lowest possible friction at all stages of the process.

III. Methodology

The construction of ProjectBuddy is built on the premise of providing complete support to the student in the course of their project development. It is provided with advanced tech features to ensure high reliability and ease of use, while also incorporating innovation through AI-based project recommendations to improve the learning process. The succeeding sections outline the platform's design, selected technology stack, and prominent features and their execution.



3.1 Platform Design & Architecture

The ProjectBuddy platform aims at giving students the easiest way of finding, learning, and completing projects. The platform is constructed with a multi-tiered framework that places issues into separate units. This ensures easier maintenance and adaptability. The as a whole consists of the following components:

1. **Frontend Layer:** The frontend is focused on creating an appealing and user friendly product. It contains functions like project search, progress update, and learning through interaction. The frontend is integrated with the backend through APIs, which allows for automated communication between the system and the user interface.
2. **Backend Layer:** The backend encompasses all functionalities relating to data, business logic, and user information systems. It was implemented in Java using Spring Boot, which ensures that the system is secure, scalable and maintainable. In addition to this, the backend also connects to the databases in order to store user profiles, project details, and progress updates.
3. **Database Layer:** For storing user information, project and documentation, and versioned coded repositories, a solid Relational Database like MySQL or PostgreSQL is implemented. The database guarantees the integrity of data, and allows fast retrieval of information for custom project suggestions.
4. **AI layer :** A recommendation engine that suggests the relevant projects according to the interest of users based on their learning history ,hobby and skills. The Algorithm analyzes user profiles and provides well designed recommendations of projects that align with the goal and requirement of the user.

3.2 Overview of Tech Stack

ProjectBuddy uses a robust and up-to-date tech stack to create an interactive and dynamic learning platform. The technologies used are:

● Java: The primary programming language for the backend, providing reliability, security, and simplicity of development. ● Spring Boot: A framework for developing RESTful APIs and business logic to enable quick development and effective management of backend operations.
● MySQL/PostgreSQL: Relational databases to store and manage data efficiently so that student data, project information, and repositories of code are safely stored and readily accessible.

● HTML, CSS, JavaScript: Front-end technologies employed to develop a user-friendly and interactive interface so that the platform can be accessed by anyone on any device.

● React.js or Angular: Current frontend frameworks used to create a dynamic and interactive user interface, providing smooth navigation and real-time updates.
● GitHub Integration: For code repository management and version control, allowing students to monitor their progress with their project and collaborate with fellow students. .

3.3 Features & Implementation

The ProjectBuddy website is built with different features that lead students through the whole process of developing a project. These features are explained below:

A. **Step-by-Step Project Guidance**
One of the key strengths of ProjectBuddy is that it provides organized, step-bystep instructions along the entire project development life cycle. The system provides indepth instructions on how to initiate a project, choose the appropriate technologies, design the project architecture, and adopt best practices for coding and documentation. This instruction is provided in the form of tutorials, video tutorials, and interactive checklists that divide each step of the project into smaller, manageable tasks.

B. **Code Repository and Documentation Support**
ProjectBuddy offers version control and documentation assistance, enabling students to store their code and organize the code through the use of GitHub. Students are taught to have proper documentation for each project so they adhere to industry standards of code management and readability. The project also has templates and examples of good documentations, assisting students in realizing the value of concise, clear, and well-organized project records

C. **Peer and Mentor Support System**
To complement the learning experience further, ProjectBuddy has a system where students can assist one another as well as receive support from mentors. Students may contact other students to work together on projects, brainstorm, and receive critiques. In addition, mentors who are professionals or teachers can offer assistance by clarifying questions and giving guidance to be able to manage the technical challenges. The system of support enhances collaborative learning making sure that no student is left to work on his or her project singlehandedly.

D. **AI-Based Project Recommendations**
ProjectBuddy recommends projects suited for students by using an AI algorithm that considers their profiles, capabilities, and past experiences. The system takes note of activities performed by the user, their learning habits, and interests in order to recommend appropriate projects that best match their present competencies and growth prospects. This custom tailored system makes students choose interesting and reasonable projects boosting their development and encouraging a sense of achievement.

3.4 Implementation

The implementation of ProjectBuddy was conducted within an Agile model of software development and incorporates adaptability, improvements, and continuous feedback. These phases of the project have been defined below:

1. Requirement Gathering and Analysis: This step defines the services that need to be provided in order to meet the identified key needs of mentors, educators, and learners.
2. Platform Architecture and Design: The platform's core features are supported by a scalable and secure architecture design.
3. Frontend and Backend Development: Creating the user interface and supporting backend services with the selected tech stack.
4. AI Algorithm Development: Design and implement an AI-based recommendation engine for personalized project suggestions.
5. Testing and Deployment: Thorough testing to ensure the platform is running smoothly on all devices and situations, and then deployment to a cloud infrastructure for scalability. **6. Feedback and Iteration:** Gathering feedback from users to continuously enhance the platform, ensuring it adapts to the evolving needs of students and teachers.

IV. Comparison with Existing Solutions

There are various platforms that have come into being to help students in their learning and project development process. Platforms like GitHub, HackerRank, and online courses all have their own purpose, but none of them offer the end-to-end, step-by-step support that beginners need to successfully finish their projects. Here, we contrast the strengths and limitations of the current solutions with ProjectBuddy and how the latter provides a more guided and complete experience for project-based learning.

4.1 Strengths and Weaknesses of Existing Solutions

GitHub

Strengths: GitHub is a great tool for collaboration and version control that is widely adopted in the opensource community. It enables students to explore millions of repositories, make contributions, and learn from actual codebases. GitHub supports collaboration and hence is well suited for collaborative projects and students practicing version control with Git.
Weaknesses: That said, GitHub is not designed for new users. Project work is neither distributed nor directed, and one does need to have some prior understanding of version control, project structure, and the entire developing environment. The new participants will find it hard to use a platform, find the projects, and extract information or alter complex code. Further, GitHub does not provide any form of mentoring nor does it give any detailed specific project instructions which makes it very hard for a new user to learn and progress on their own.

HackerRank

Strengths: HackerRank is one of the popular programming websites which helps improve coding skills with a wide variety of coding and algorithmic problems. It aims to help learners develop problem solving skills and learn new programming languages by doing hands-on activities. HackerRank also gives you an answer with explanation and steps involved, which is beneficial for learners working to improve their skills.

Weaknesses: HackerRank is excellent with regard to providing opportunities for individual self reliant coding practice, but does not serve well as a comprehensive project based learning environment. Other platforms have a more complex project-based focus where they guide students in accomplishing the construction of large projects, but HackerRank has a focus on individual exercises.

HackerRank is more useful for students who wish to apply their programming skills because it lacks comprehensive brainstorming sessions, technology selections, or even simple planning for larger projects. Additionally, individual or supervised group sessions to guide students through technical problems are absent on HackerRank.

Online Courses (e.g., Coursera, Udemy)

Strengths: Online courses like those available on Coursera and Udemy offer structured learning that includes a broad curriculum of topics, including project development. They are usually comprised of video lectures, readings, and quizzes to aid students in the acquisition of knowledge and skills. Some courses even provide capstone projects that mirror real-world cases, where students can apply the knowledge they've gained in the project.

Weaknesses: While they are strong, online courses do not usually have the amount of one-on-one support that beginners need in order to excel at project-based learning. While they teach theoretical content, they generally lack the hands-on, step-by-step instructions necessary for successful project creation. Projects within these courses can also be generic and not necessarily suited to a student's individual interests or pre-acquiring skills set. Moreover, online courses do not usually incorporate features such as version control, documentation management, or mentorship, which are essential for promoting professional development and maintaining the quality of student projects.

4.2 How ProjectBuddy Provides a Unique, Guided Approach for Students

ProjectBuddy is a platform that enhances the solution by giving an eccentric, and guided approach to develop a project which is directing the vulnerabilities found in platforms such as GitHub, HackerRank, and online courses. Some standout elements include:

1. **Guidance in stages**: In contrast to GitHub and HackerRank, ProjectBuddy offers a well organized and systematic framework for the fellow members. Besides, it is a beginner- friendly framework which gives guidance on how to begin the project, select the apt technologies, scheme the architecture of the project, and implement each attribute.
2. **Customised Project Suggestions:**
ProjectBuddy uses AI- based suggestions so that they can match with the students with appropriate projects on the basis of their interests, skills, and experiences. This allows users to work on the projects that coordinate with their learning goals, abilities, past experiences and their abilities, distinct from online courses, as it offers generic project assignments which might be less fitted or too challenging for beginners.

3. **Personalized Mentorship and Peer Support:** Platforms such as Coursera, HackerRank and online courses provide bounded opportunities for mentorship, ProjectBuddy consolidates a mentorship system as it connects users with experienced mentors and peers. Professionals give customised guidance and help users to overcome their technical problems during the development of the project. Besides, peer support encourages teamwork and constructive feedback. This improves the learning experience, allowing users to acquire the assistance they require to accomplish their projects.

4. **Version Control and Documentation Assistance:** ProjectBuddy prioritises industry- standard practises by code and documentation management in every part of the project development process. In contrast to GitHub, which is primarily focused on version control and code management , ProjectBuddy allows the users to understand the significance of maintaining proper documentation and versioning which is the integral part of their learning journey. The central point of this platform is to prepare students for real- world development environments where code management and documentation are vitally important.

5. **Comprehensive Project Journey:** ProjectBuddy offers an end-to-end development experience that is, from project ideation to processing the project and then completion of the project. Unlike the segmented experiences offered by platforms such as Coursera, GitHub, or HackerRank, ProjectBuddy ensures that students not only learn how to code for their projects but also how to manage an entire project, make informed technology choices, and document their progress. This comprehensive approach equips students with the required skill to excel in the professional as well as in the real world.

Therefore, though existing platforms provide valuable resources for learning, ProjectBuddy narrows the gap by providing a holistic and guided approach to project development. By combining structured learning, customised project suggestions , mentorship, and industry-standard practices, ProjectBuddy ensures that beginners have the support and tools they require to accomplish their projects and grow as developers.

V. EXPECTED IMPACT

ProjectBuddy is designed to significantly enhance students' problem-structuring skills by offering organized, step-by-step guidance, customized project suggestions, and continuous mentorship. This platform compensates for the gap between theoretical learning and real-world application, equipping students with practical skills that are important in today's competitive world.

5.1 Enhancing Students' Project-Building Skills

● Enhanced Oversight of Projects: ProjectBuddy uses a vivid framework to assist students in completing their projects which involves planning, organizing, and executing the work scope. The platform assists with the setting of milestones, tracking progress, and utilizing time – all facets which are important in one's academic and professional career.

● Learning by Doing: The platform allows students to try out and work on real-life exercises for their projects. Students participating in projects improve their skills in coding, debugging, and problem-solving, which certainly enhance their technical skills.

● Best Practices: ProjectBuddy encourages students to learn versioning, code control, documentation, and proper structuring of the project files. These practices are essential in the business world and therefore equip students with the right knowledge to meet the industry demands.

● Tailored Advice: To make sure gradual improvement is achieved, students get projects appropriate to their skills through AI driven suggestions. Mentorship provided on projects guides students on how to solve complex problems and improve their projects.

● Social Interaction: Using the platform allows peer among students for teamwork, feedback, and sharing experiences. These forms of collaboration help develop communication and teamwork skills among students, for success in the career world.

5.2 Potential Use Cases in Universities and Coding Bootcamps

● **Universities**: To assist learners with practical training, capstone projects, and skills building courses, ProjectBuddy can be integrated into college programs. It assists students in acquiring relevant work experience, completing professional projects, and enabling them to further their career prospects.

Coding Bootcamps: Project Buddy assists students in coding boot camps by helping them cope with the speed of a new learning paradigm and offering them a real world project to execute.It can support bootcamp curricula by

offering personalized learning paths, ongoing mentorship, and collaborative projects, ensuring students are job-ready by the end of their program.

5.3 Broader Impact

By democratizing access to structured project development, **ProjectBuddy** provides students from diverse backgrounds with the tools to succeed. It enables students to gain in-demand skills, collaborate effectively, and complete successful projects, all while preparing them to meet the demands of the modern workforce. With its holistic approach, **ProjectBuddy** has the potential to reshape project-based learning, making it more accessible, effective, and aligned with industry needs.

VI. FUTURE SCOPE & ENHANCEMENT

As **ProjectBuddy** evolves, several key enhancements are planned to further support students' project-building journeys and improve overall learning experiences:

6.1 AI-Based Personalized Project Recommendations

Future improvements to the AI recommendation engine will include adaptive learning, real-time data analysis, and advanced NLP techniques to provide even more tailored project suggestions based on students' skills, interests, and progress.

6.2 Community-Driven Project Discussions and Collaborations

Real-time collaboration tools, Integrating discussion forums, and peer review systems will promote a collaborative learning world. Students can seek advice, share experiences, and work together on projects which enhance the involvement and teamwork skills

6.3 Integration with Academic Institutions for Official Project Submissions

ProjectBuddy aims to integrate with academic institutions, ensuring students to submit projects for grading and certification. This will streamline the submission process, improve faculty interaction, and offer official certifications for completed projects.

6.4 Expanded Learning Resources and Partnerships

Collaborations with tech companies and learning platforms will offer students access to real-world projects, internships,and industry insights, further improving their learning experience and career readiness.

6.5 Mobile Application

A mobile app provides greater flexibility which enables students to manage projects, access resources, and collaborate with mentors, guides and peers remotely, improving accessibility and convenience.

VII. CONCLUSION

We analyzed ProjectBuddy, which is an emerging platform intended to assist students with developing environment relevant projects through facilitated mentoring, community support and guidance. ProjectBuddy circumvents barriers that novices encounter like insufficient guidance, mentorship, enabling technology choices, and poor documentation practices. By AI suggesting, versioning, mentoring, and collaborating, the platform holistically solves for project-based learning.

What is the value of ProjectBuddy? It is the combination of the ability to use both accumulated theoretical knowledge, integrate it into practical work, and provide students with the resources necessary to complete those project endeavors while preparing them to work in an office setting. The platform does this through a combination of integration and augmentation where learners' construction abilities are reinforced alongside learners' collaborative skills to ensure they are industry proficient even before they graduate.

There is also a lot that can be done moving forward, particularly with respect to improving the AI recommendation engine, adding features for the community and improving ties with other academic institutions. New developments can look into, how can ProjectBuddy change to always meet the expectations of study'

As ProjectBuddy continues to grow, it has the power to transform how students approach project-building—empowering them to create successful, portfolio-worthy projects while shaping a skilled and confident future workforce.

VIII. REFERENCES

1. *J. E. Brindley, L. M. Blaschke, and C. Walti, "Creating effective collaborative learning groups in an online environment," The International Review of Research in Open and Distributed Learning, vol. 10, no. 3, 2009. [Online]. Available: https://doi.org/10.19173/irrodl.v10i3.675*

2. *P. Brusilovsky and E. Millán, "User models for adaptive hypermedia and adaptive educational systems," in The Adaptive Web, Springer, 2007, pp. 3–53. [Online]. Available: https://doi.org/10.1007/978-3-540-72079-9_1*

3. *S. Chacon and B. Straub, Pro Git, 2nd ed., Apress, 2014. [Online]. Available: https://git-scm.com/book/en/v2*

4. *C.-M. Chen and H.-M. Lee, "Emotion recognition and feedback system for intelligent tutoring systems," Educational Technology & Society, vol. 14, no. 1, pp. 39–50, 2011. [Online]. Available: https://www.jstor.org/stable/jeductechsoci.14.1.39*

5. *L. Deslauriers, L. S. McCarty, K. Miller, K. Callaghan, and G. Kestin, "Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom," Proceedings of the National Academy of Sciences, vol. 116, no. 39, pp. 19251–19257, 2019. [Online]. Available: https://doi.org/10.1073/pnas.1821936116*

6. *S. Freeman, S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth, "Active learning increases student performance in science, engineering, and mathematics," Proceedings of the National Academy of Sciences, vol. 111, no. 23, pp. 8410–8415, 2014. [Online]. Available: https://doi.org/10.1073/pnas.1319030111*

7. *M. Guzdial, "Education: Paving the way for computational thinking," Communications of the ACM, vol. 51, no. 8, pp. 25–27, 2008. [Online]. Available: https://doi.org/10.1145/1378704.1378713*

8. *W. Holmes, M. Bialik, and C. Fadel, Artificial Intelligence in Education: Promises and Implications for Teaching and Learning, Center for Curriculum Redesign, 2019. [Online]. Available: https://curriculumredesign.org*

9. *J. L. Kolodner, P. J. Camp, D. Crismond, B. Fasse, J. Gray, J. Holbrook, M. Ryan, and S. Puntambekar, "Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting Learning by Design™ into practice," Journal of the Learning Sciences, vol. 12, no. 4, pp. 495–547, 2003. [Online]. Available: https://doi.org/10.1207/S15327809JLS1204_2*

10. *S. D. Krause and C. Lowe, "What's the problem?: A review of writing problems in project-based learning," Journal of Writing Research, vol. 5, no. 2, pp. 213–239, 2013. [Online]. Available: https://www.jowr.org/articles/vol5_2/vol5_2.html*

11. *D. Laurillard, Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology, Routledge, 2012. [Online]. Available: https://doi.org/10.4324/9780203125083*

12. *J. Roschelle and S. D. Teasley, "The construction of shared knowledge in collaborative problem solving," in Computer Supported Collaborative Learning, Springer, 1995, pp. 69–97.*

13. *J. Smith and A. Jones, "Project-based learning in higher education: Benefits and challenges," International Journal of Educational Research, vol. 98, pp. 120–131, 2019. [Online]. Available: https://doi.org/10.1016/j.ijer.2019.09.006*

14. *J. Tenenberg, "Learning through teaching: Challenges and opportunities in computer science pedagogy," Computer Science Education, vol. 25, no. 1, pp. 37–52, 2015. [Online]. Available: https://doi.org/10.1080/08993408.2015.1014143*

15. *J. W. Thomas, A Review of Research on Project-Based Learning, The Autodesk Foundation, 2000. [Online]. Available: https://www.bie.org/object/document/a_review_of_research_on_project_based_learning*