Collaborative Coding Development using Interactive e-Learning for Programming Courses

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Abstract—

This paper addresses the challenges faced in e-learning environment where learning management system used for active learning. Theses system involves several challenges, such as lack of interaction, instant communication and feedback in programming coding sessions. To overcome these challenges, we have proposed and successfully implemented e-learning management system for professional courses with a Collaborative Integrated Development Environment (CIDE) feature. This feature allows instructors to track the real-time progress of development of each student, enabling them to conduct interactive sessions and provide timely feedback. The demand for e-learning platforms is expected to increase in the future, catering to individuals from online/remote areas and those pursuing part-time degrees or learning new skills of coding while doing jobs. However, existing platforms often lack essential features like interaction with students. This paper aims to address these limitations by incorporating a real-time collaborative IDE into the e-learning platform, capable of tracking student progress and identifying any misconduct. The results show collaborative coding helps in interactive learning computer programming language code and learners are highly satisfied with collaborative LMS.

Keywords—Collaborative learning; eLearning; Learning management systems; online coding;

I. INTRODUCTION

A skilled education is essential for professional system of education such as coding skills. It is necessary for any learner of computer programming languages to meet the need of the job skillset and ever-evolving demands of the digital literate modern workforce for experienced programmers. In today's digital learning environment, professionals are expected to possess a wide range of skill sets, including industry-domain knowledge, technological adaptability, and problem-solving aptitude. These varied skill sets can no longer be imparted to students through traditional professional education. Interactive coding collaboration in professional education is an alluring way to overcome this challenge. The context and background of the research are deeply ingrained in the ways that technology is transforming numerous industries. Long-standing industrial practices have been upended by technological advancements in recent decades, prompting the need for a workforce with coding skills and digital literacy for a variety of online activities, as well as computational reasoning.

As a result, companies and educational institutions have realized that they must review their professional education programs to adjust to the evolving needs of the skill set that students have learned. The term "interactive coding collaboration" describes an educational strategy that blends the concepts of interactive learning with coding in professional settings. Students who collaborate on code projects with peers, instructors, or industry experts gain the self-assurance to take an active role in their coding education. Problem solving, cooperation, and experience learning are three fundamental tenets of interactive coding collaboration. Along with developing important technical and social skills, students also feel more in control of their education and are able to apply theory to practical issues.

According to educational studies, students benefit greatly from real-world experience, especially in professional courses where they may use their theoretical knowledge to solve social issues. Through interactive code collaboration, students may collaborate on real-world projects, test out new coding approaches, and tackle tough challenges as a team. The demands of modern business, where professionals must collaborate in diverse teams and use technical abilities to solve practical problems, are reflected in this active learning approach. The backdrop of this study is influenced by the change in professional domains toward digital transformation. Significant changes are occurring in several industries, including the use of data analytics, automation, and artificial intelligence.

By means of interactive coding, through cooperation, students may work together to solve complex real-world problems, try out new coding techniques, debug issues, and work on real-world projects. Additionally, the pandemic's implications on distant work and digitization have raised the professional proficiency with digital tools and technology is required.

Consequently, interactive coding collaboration has grown in significance within the educational system and professional courses. Nevertheless, including interactive coding cooperation into professional education presents some difficulties. The key challenges are ensuring fair access to resources, training teachers to support collaborative learning, creating efficient assessment strategies, and modifying these approaches for use in a range of professional contexts. The evaluation of the advantages of interactive coding collaboration in professional programming coding courses and educational systems is the focus of this research. By doing this, it hopes to support the continuous advancement of professional

education and the creation of a workforce with the necessary skills to succeed in the modern, fast-paced workplace.
The advent of e-learning platforms has caused a significant upheaval in the education sector in recent years. Regardless of their location or background, learners may now access instructional resources and acquire new skills thanks to these platforms. However, despite all of e-learning's advantages, problems still need to be fixed in order to provide a comprehensive and interesting learning environment. This study presents a unique implementation that uses the Integrated Development Environment's (IDE) collaborative coding functionality to enhance the e-learning process. In the context of professional courses, this article aims to provide online computer programming language coding classes and assessments.

This solution offers a fruitful and engaging learning environment for computer programming language coding by addressing the core problems of engagement, real-time communication, and feedback. The technique involves creating a real-time, interactive, collaborative IDE using easily accessible software tools. As we carefully evaluate each student's CIDE activities, we record their progress and save it in a database. The procedure of identifying typing misconduct entails monitoring tempo and flagging quick strokes as potentially inappropriate. This program efficiently addresses the drawbacks of existing e-learning systems by lowering students' fears about their future career paths and skill sets and providing instructors with real-time information about the student process during the course.

The absence of real-time contact and feedback, particularly during coding sessions, is one of the main problems with e-learning. Because they are unable to track each student's improvement in real time, computer science educators frequently rely on the finished product for evaluation and criticism. This restriction makes it more difficult for them to lead engaging lessons and provide students quick, focused feedback. More effective teaching and learning experiences will be possible if instructors can monitor and track each student's progress in real time by integrating a collaborative learning environment (CIDE) into the e-learning management system.
Additionally, addressing the problem of misbehavior in coding evaluations is the goal of the Collaborative IDE (CIDE) function.

Mechanisms to monitor and stop plagiarism or unapproved cooperation during coding activities in e-learning settings are currently lacking. The system will be able to track student actions, spot any possible wrongdoing, and give teachers the knowledge they need to uphold academic integrity by implementing a real-time Collaborative (CIDE). By incorporating a collaborative learning environment (CIDE) into the e-learning management system, teachers may track and monitor each student's progress in real time, enabling more effective teaching and learning experiences. The Collaborative IDE is also (CIDE) makes an effort to address the issue of misconduct in coding tests. There are now few technologies available to monitor and prevent plagiarism or unauthorized cooperation during project coding in e-learning settings, and there are also insufficient protections in place at the moment. Through the implementation of a real-time Collaborative (CIDE), the system will be able to monitor student behavior, identify any potential misconduct, and provide instructors with the knowledge they need to maintain academic integrity.

1.1 Learning Theories:

These beliefs are extremely pertinent when discussing collaborative coding in professional courses: Learning theories that offer a theoretical basis for comprehending how students pick up knowledge, process information, and hone their problem-solving abilities include behaviorism, cognitivism, and constructivism. Behaviorist concepts place a strong emphasis on the role that practice, reinforcement, and feedback play in learning. This is demonstrated by the iterative coding process in collaborative coding, where students get feedback on their work, make changes, and apply what they have learned.
The main focus of cognitivist ideas is on how students absorb information, work through issues, and reach conclusions. According to cognitivist principles, collaborative coding necessitates cognitive functions including code analysis, debugging, and well-informed coding decisions. Particularly pertinent are constructivist learning theories, which place an emphasis on students' active participation and knowledge production. Through active construction of their understanding of code, students work with others to develop and hone their skills in collaborative coding.

1.2. Collaborative Learning Theories:

Theories of collaborative learning shed light on how people learn in social settings and how peer interactions might improve learning. Social engagement, shared knowledge production, and peer interaction are important tenets of collaborative learning. These ideas highlight how crucial it is for students to collaborate, talk about coding difficulties, and solve problems as a group when it comes to collaborative coding. Collaborative coding in professional courses is a great fit for constructivist e-learning methodologies. These methods place a high value on knowledge development, problem-solving, and active learning. Students work on coding projects,

building their comprehension of coding concepts and experimenting with solutions. In line with the goals of collaborative coding, constructivist e-learning environments enable students to investigate coding principles, use them in practical situations, and report on their coding experiences. The design and execution of collaborative coding exercises in professional courses are guided by a number of models and frameworks that offer an organized method for interactive coding collaboration. One of these techniques, called Pair Programming, promotes two programmers to collaborate at a single computer. The navigator reviews and makes suggestions for changes, while the driver writes the code. This methodology encourages code quality and improves collaborative coding abilities. Iterative development and collaborative coding are key components of agile approaches.

Continuous integration, sprint planning, and daily stand-up meetings are examples of agile methods that promote cooperation and teamwork among programmers. Git Flow frameworks and version control systems are crucial for collaborative development because they enable numerous developers to work on a codebase at once, merge changes, and cooperatively manage code repositories. The Community of Inquiry (CoI) Framework places a strong emphasis on online learning environments' cognitive, social, and instructional components. When it comes to collaborative coding, it offers an organized method for guiding group coding exercises while taking social interaction, cognitive engagement, and instructional assistance into account. "How can interactive coding collaboration be effectively integrated into professional education to enhance learning outcomes and prepare individuals for the complexities of the modern workplace?" is the main issue this study attempts to solve.

1.3 Research Objectives

The primary objectives of this research are to explore the impact of interactive coding collaboration on professional education and to develop best practices and guidelines for its effective implementation. This study will address the following key research questions:

1. How does interactive coding collaboration improve the learning experience in coding programming education programs?
2. What are the pedagogical approaches for integrating collaborative coding in professional courses?
3. What are the challenges and obstacles in implementing interactive coding collaboration in various professional domains, and how can they be overcome?

1.4 Significance of the Study:

The research on Collaborative Coding Development using Interactive e-Learning for Program Courses holds significant importance for several key stakeholders and has broad-reaching implications in multiple domains. The study's significance lies in its potential to reshape and improve professional education in the digital age, offering transformative benefits to various stakeholders:
This research provides valuable insights and guidelines for educators and academic institutions seeking to modernize and optimize their professional education programs. By understanding the impact and best practices of interactive coding collaboration, they can enhance the quality of instruction, improve student engagement, and better prepare learners for the realities of the modern workforce.
The research study can inspire future research endeavors in the field of education, technology, and professional development. It makes it possible to do more research on cutting-edge teaching strategies, use cutting-edge technology, and create fresh approaches to evaluation.

1.5 Contributions:

The study contributes to the broader academic and research community by shedding light on the effectiveness of interactive coding collaboration as an educational approach. It contributes to current discussions and arguments about pedagogy, educational philosophy, and the application of technology in professional education. The field of professional education programming coding environment for skill development has benefited greatly from this research:

1 It highlights the value of interactive coding collaboration in preparing professionals for the challenges of their careers.

2 The research provides insights into the pedagogical strategies, best practices, and assessment methods that promote effective collaborative coding in professional courses.

3 The research underscores the significance of feedback, reflection, and motivational aspects in collaborative coding projects.

This implementation seeks to improve the online learning experience, encourage real-time interaction and feedback, stop misconduct, and offer individualized assistance for students' future skill development through the inclusion of a Collaborative (CIDE) coding tool. Through tackling these issues, the present work makes a valuable contribution to the continuous development of e-learning platforms and provides students with an enhanced and productive learning environment for learning any computer programming language.
The structure of the paper is as follows. Section II describes literature review for finding out latest work done in this domain of e-learning and learning management system. Section III explains methodology and techniques used in the implementation, including the software tools used and the evaluation procedures. Section IV covers results of implemented collaborative LMS system. The outcomes and described in Section V. Section VI presents conclusion of the paper and possible directions for future improvements.

II LITERATURE REVIEW

The collaborative learning feature is crucial for encouraging student participation, knowledge creation, and the growth of critical thinking abilities. In an effort to offer guidance and suggestions for educators and organizations looking to implement collaborative learning techniques in remote learning environments, this study explores the importance of collaborative learning in emphasizes both its advantages and disadvantages. Khadijah Mukhtar et al. (2020) given a thorough search of sixteen databases' worth of literature was undertaken. Comfort, accessibility, and distance learning were among the benefits. It was suggested that teachers receive training on using online modalities and create lesson plans with more interactivity and less cognitive burden. The constraints included difficulties upholding academic integrity and inefficiency. Arshi Naim (2020) explains that the discussion forum was the best electronic tools to satisfy the requirements of a broad student body and achieve the learning objective of this specific Information Systems Module by 2021. Tools must replicate the in-class, real-time learning process.

This isn't the end of that. Open-distance learning (ODL) was investigated by Nur Syaq (2020) and implemented for the current semester through December 31, 2020. Compared to a regular classroom, online distance learning offers a distinct kind of learning environment where students must be self-reliant in their pursuit of knowledge. Students emphasized several benefits of online distance learning (ODL), including the ability to learn at their own pace and the use of pre-recorded videos for keeping up with new content. More than half of the students find ODL to be enjoyable, however just one-third. The primary cause of the study's findings that students dislike ODL is a bad internet connection. C. Xiao-hua (2021) investigated citation analysis revealed that the most extensively studied software for teaching programming is Scratch. Students can develop effective programs and share knowledge through pair and collaborative programming. Assessment systems assist teachers in assessing student-written programs and give them feedback on time. They must be improved in efficiency. Comfort, accessibility, and distance learning were among the benefits. Since this was the sole option for education, it was a blessing for the field, but it also had drawbacks, such as slowness and difficulties upholding academic integrity. The inability of the students to learn because the collaborative IDE was not able to fix the student codes in real time, the students were unable to learn how to properly explain the coding challenges as given by the lecturers entire system when doing hands-on assessments. It was suggested that teachers receive training in using online modalities and creating lesson plans that prioritizes interaction over cognitive burden. Every step the kids take forward should be examined, and their performance should be valued. Zohreh Saadati (2021). The recommendations made by researchers to solve the issues with online learning are reflected in Deepti Khanna and Ayush Prasad's (2021) research, which focuses on five main areas: relationships, instruction, content, motivation, and mental health. Preparation, class delivery, course quality, communication, student-teacher interaction, and student participation are other important solutions. The study's findings can assist teachers in selecting the most practical and efficient platform that pupils choose. It thereafter will help determine the best course of action for preparing ODL materials during the COVID-19 pandemic, therefore simplifying this storage procedure. According to Jason Vandeventer and Benjamin Barbour (2012), CodeWave's goal is to provide professors and students with a real-time, collaborative IDE. The issue with using IDEs in educational settings is that they usually do not consider a collaborative approach by default. They are advised of several instruments that would greatly improve the effectiveness of group or instructor-student collaboration. Annotation, logging, and built-in collaboration offer answers too many of the issues that distance learning students must deal with. Through real-time cooperation and disconnected support via messaging and annotations, it continues to be able to conduct connected training. Dan Li (2020) the study makes the case that technology, particularly in computer science degrees, may significantly improve the online learning environment. The research describes that it might not take into account outside variables that could influence the adoption of technologically enhanced online learning, such as socioeconomic position or access to technology. Juan Carlos Gómez-Sán (2021) the study makes the case that teaching programming during a pandemic can be accomplished through blended learning. It might not take into account the real-world difficulties involved in integrating blended learning into various courses of educational systems.

The use of Onyebuchi, E. C., & Onyebuchi, C. C. (2021) Students' performance can be enhanced by using virtual laboratories in addition to traditional classroom training. The study does not evaluate the long-term retention of knowledge, instead concentrating solely on the immediate impacts of the virtual laboratory on students' conceptual understanding. Conceptual knowledge of the field of computer science. Google Classroom is an online learning tool that, according to Hariadi Hariadi and Rifqi Fauzi (2021), has a positive effect on students' interest and participation in studying Indonesian during the pandemic. The document provides it ignores alternative online learning platforms and primarily concentrates on using Google Classroom as a medium for online learning. Selahattin Cirakoglu (2022) describes how students faced challenges such as technical issues, a decline in motivation, and difficulty acclimating to new settings for learning. The study's limitation is that its findings might not apply to other fields because it just concentrates on dentistry. Aparicio-Na Varro, Juan-Manue; and Hernández-García, García, Navarro-Lopez, Jose-Luis (2022) describes individual differences in learning styles and preferences that could affect student happiness with distance learning, the authors' goal is to better understand the elements that influence student satisfaction in order to increase the effectiveness of distant learning. Researchers Rania A. Al-Zu'bi and Ahmad S. Al-Eid (2021) look into how artificial intelligence (AI) can affect higher education. The study examines the manner in which artificial intelligence (AI) is being used in higher education now and in the future through a survey of the literature. The study comes to the conclusion that while implementing AI in higher education has numerous advantages, there are also crucial factors to take into account, such as concerns about equity and access to the authorized course.

Dr. Jharna Majumdar and Rupesh K.S. (2020) explained a restricted amount of study has been conducted on the effects of the pandemic on education and the transition to online learning, despite the fact that many techniques and technologies are being employed to improve the efficacy of e-learning. Al-Bahrani, Ahmed (2016) described one approach was preferred over the other in terms of assisting the learning process, according to the findings of a poll given to teachers and students who had used both. Research studies frequently have limitations, including limited sample sizes, poor generalizability, and possible survey biases. In addition to discussing the subjectivity of self-reported survey results and the small sample size and demographic representation, Arshi Nain (2021) demonstrated how e-learning tools might improve student performance and engagement. Koemhong Sol and Kimkong Heng (2021) explored important issues such limited access to technology, low engagement, and inadequate support for educators and students were noted in a review of the literature. The results could be impacted by the writers' personal prejudices and viewpoints, and the literature study might not have included all the pertinent research and sources. Ahsan Sethi, Kainat Javed, Mahwish Arooj, and Khadijah Mukhtar (2021) examine the elements of technology, instruction, and student involvement that impact the effectiveness of online learning. The information utilized to bolster the findings could be constrained or out of date, considering how quickly the pandemic's conditions are changing and how online learning is being implemented. A. Santos, J. Cravino, and R. Manhiça (2022) outlines the potential applications of artificial intelligence for user assistance in learning management systems. This can assist with recommendations for careers and courses, as well as with taking classes on new technology and tackling challenging challenges. Ibrahim, F., Susanto, H., Abdullah, J., and Subramanian, U. (2022). Presents clarification for how cloud computing could emerge as e-learning's primary driving factor. How the field of e-learning can progress with this revolutionary technology. This report discusses the e-learning environment's infrastructure and cloud services. Furthermore, in-depth analyses of the ways in which cloud computing impacts e-learning, in addition to be constrained or out-of-date, considering the pandemic's quickly evolving conditions and the introduction of security features and concerns. It may be possible to optimize the advantages of merging these fields with system auditing. The learning management system can be accessed and used without the need to install any special hardware or software, according to a solution offered by N. M. S. Suramery and M. Shakor (2021). Explains the capacity of the learning management systems in the distance learning engineering courses is examined by Alam, M. N. H., Othman, R., & Mohd Yunos, S. N.M. in 2021. Burney, S.M., Fawad Alam, Aqil In this article, the modified DeLone and McLean Information System Success Model is presented by Burney, Shamaila (2022) to analyze the Moodle Learning Management System's success among Brunei's University Technology instructors and students. By assessing students' performance in MOOCs, the authors H. Aoulad Ali, C. Mohamed, B. Abdelhamid, and T. Alami (2021) presents an integrated machine learning programme that will assist in recommending courses to students. Canan Perkan Zeki and Zohreh Saadati (2020) created a blockchain-enabled learning management system (LMS) with SRL adaptive intervention (AI) as a metacognitive tool for online higher education to enhance planning. Table 1 shows compressions of different features supported by existing learning management systems. The collaborative coding environment feature not included in many exiting learning management systems. We have designed system of the collaborative coding environment as shown in fig. 2

Table 1: Comparison of LMS systems

Sr. No	LMS	Live Lessons	Collaborating IDE	Open Source
1	iSpring learn	Yes	No	Yes
2	Adobe captivate prime	Ye	No	No
3	SapLitmos	Yes	No	Yes
4	TalentLMS	Yes	No	No
5	LearnUpon	Yes	No	No
6	Moodle	Yes	No	Yes
7	Sakai	Yes	No	Yes
8	**LearnGo**	Yes	**Yes**	No

III. METHODOLOGY

The recent development in e-learning has completely changed the way student receive an education by giving them access to courses and information regardless of their time or location. There are still a number of issues, such as the absence of real-time engagement, feedback, and communication in coding sessions and evaluations. The purpose of this research is to address these issues and improve the quality of the learning process by examining the approach used in the implementation of a Collaborative Integrated Development Environment (CIDE) for online learning.

A methodology that included gathering requirements, identifying challenges, choosing appropriate technologies, designing and building the system, integrating it all, tracking progress in real time, giving interactive feedback, and assessing the outcomes was used to implement the collaborative IDE for online learning. By assessing student achievement, facilitating real-time cooperation, and encouraging interactive communication between teachers and students, this comprehensive approach has resulted in a practical system that enhances student learning. The implementation of the collaborative IDE, as seen in fig. 1, represents a significant advancement in distance learning by resolving significant problems and encouraging a more engaging and effective learning environment.

First, a detailed analysis of the challenges faced by e-learning educational systems is carried out, with an emphasis on problems related to tests and coding-based teaching. The primary problems identified were the inability to track students' progress in real time, the limited communication between

teachers and students, and the challenges of providing timely feedback. To address the difficulties identified, a thorough requirements collecting procedure was conducted. To determine the essential elements and features needed in the CIDE Collaborative, it was necessary to engage with a variety of stakeholders, including educators, students, and technology experts. The criterion included feedback systems, interactive communication tools, and real-time progress monitoring.
Subsequently, a comprehensive evaluation of the existing technologies was conducted to identify the most suitable ones for implementing the CIDE. To enable real-time collaboration, code editing, and version control, the chosen technologies must be easy to use and interoperable with current remote learning platforms.

Agile software development techniques were used to create the collaborative CIDE throughout the implementation phase. The system was built and tested iteratively using iterative development cycles, which allowed for ongoing feedback and improvement. The distant learning platform was connected with the IDE to provide smooth interoperability and a consistent user experience. The CIDE was outfitted with tracking tools so that student progress could be monitored in real time. These systems recorded the code modifications, debugging sessions, and compilation mistakes made by pupils. For further examination, the progress data was safely kept in a database. Teachers and students were able to interact more easily because to the Collaborative IDE. During coding lessons and tests, teachers may now conduct interactive sessions and provide prompt feedback.

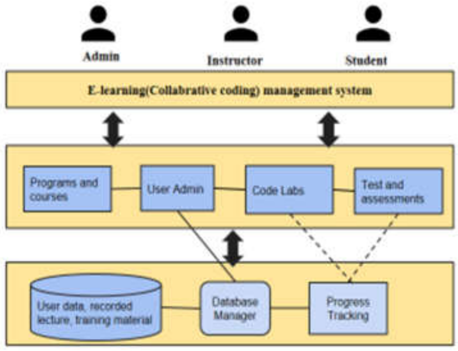


Fig 1. System Architecture for collaborative coding

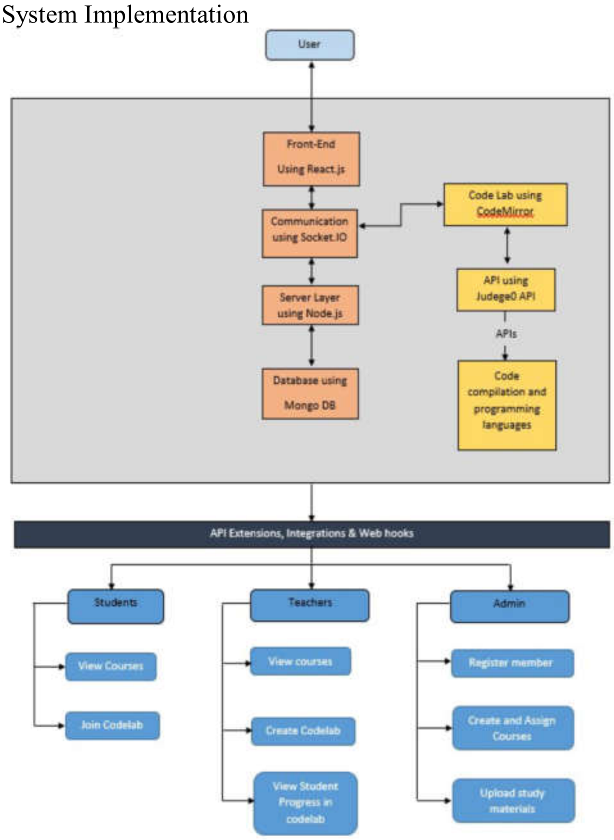
IV Design Methodology

In light of the growing popularity of learning management systems as well as the issues and constraints with the current real-time collaboration support, we presented a learning management system with an integrated development environment (IDE) for collaborative coding. First, the following three design goals are put out, providing broad direction for technical study, architectural and functional design, and prototype execution. Maintaining Complete Interoperability with the current lightweight IDE The communities have made extensive use of existing lightweight integrated development environments (IDEs) like Visual Studio Code and Sublime Text, which offer advanced functionalities and user interfaces that span a wide range of software development projects. For instance, they frequently include features and functionalities for language-specific support, intelligent help, version control, debugging, and source code editing.

In order to effectively reuse programmers' knowledge, skills, and experience in a familiar environment, the proposed environment must be fully compatible with the current single-user lightweight IDE. This means that it must preserve all current features, functionalities, user interfaces, and workflows for traditional single-user programming and non-real-time collaboration. Additionally, programmers will benefit from additional real-time collaboration functionalities derived from this research.
Using Intuitive Awareness to Support Real-Time Collaborative Programming. The proposed environment will offer extra functionality and features for real-time collaboration, while maintaining compatibility with single-user programming and non-real-time collaboration in the current lightweight IDE. During a live collaborative programming session, several programmers can simultaneously view and modify a shared set of source code directories and files, together with the contents of files containing the source code. Every programmer's modification will be instantly visible to other team members in real-time, and the system will automatically preserve the consistency of the source code copies. The suggested environment should guarantee high local responsiveness at all sites during a real-time collaboration session. This means that every local editing operation made on the source code must happen instantly and without discernible lag—that is, they must be as responsive as the local operations in conventional single-user programming without real-time collaboration. Furthermore, in a real-time collaboration session, the proposed environment will facilitate programmers' intuitive and effective awareness, helping them to avoid potential conflicts in the closely-coupled collaborative work. The host-participator model is supported by the real-time collaboration plugins is accessible to any new contributor later on and is instantly visible to other real-time collaborators. A collaborative IDE component in a learning management system designed for professional courses that monitors student progress in coding lectures and since evaluations enable students to collaborate on coding projects, exchange resources, and get immediate feedback, they can prove to be a more effective and efficient learning tool. Additionally, collaborative IDEs have capabilities like code commenting, version control, and debugging that can help students write better code. Moreover, teachers can more easily monitor and evaluate students'

progress, give timely feedback, and tailor learning paths to meet the needs of each individual student by incorporating collaborative IDEs into LMS and e-learning systems. In short , collaborative IDE integration with learning management systems (LMS) and e-learning platforms can improve the caliber of coding instruction and encourage a more dynamic and interesting learning environment.

System Implementation



V RESULTS

We have implemented system for Collaborative Coding Development using Interactive e-Learning for Programming Courses. There are three users of the system namely, Admin, Teacher and student. Each user has to login into the system and login access to system is controlled by system admin. Users have to login first into the Learning Management system collaborative coding to access the list of the code labs for a particular course as shown in Fig 1. User data (username and password) will be checked first whether it has been present in the database. If the data exists then the user will be able to log in the LMS, if not then an error will be displayed on the screen. Furthermore, the user will be redirected to the profile page; User profile, course and code labs data will be loaded from the users, code labs and courses Collections and LMS database as shown fig 2. List of assigned courses will be loaded after the user is redirected into courses page. User role will be mentioned in the badge on the navigation bar.

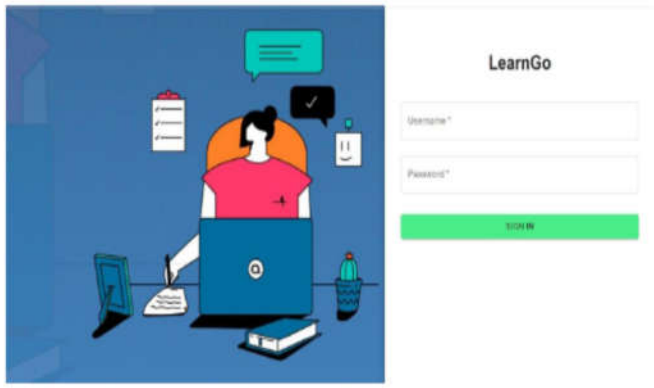


Fig 2. LearnGo System Login for collaborative coding

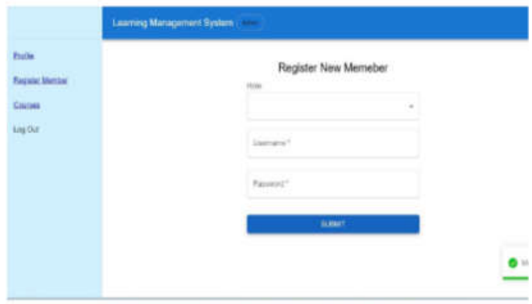


Fig 3. Adding New Member in collaborative coding

Admin

The add course option is used to add new courses into the courses collection, as shown in fig. 4, admin will enter details like course name and info to add new courses. The assign course option will be used to assign saved courses to different users, as shown as fig. 4 admin will select user name and course from the list of users and courses received from the backend to assign course to respective user.

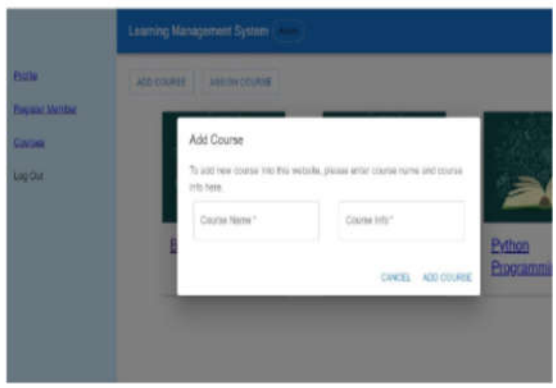


Fig 4. Adding New Course in collaborative coding

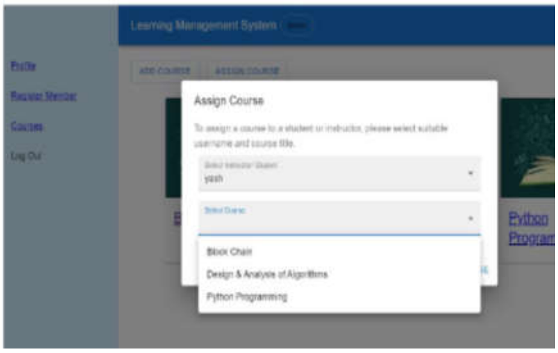


Fig.5 Assigning course to student

Fig. 5 illustrates how an admin will add a new user to the Users collection in the database. Admin will select respective role (e.g. Student or Instructor), enter username and password to add a new user into the database

Fig 5. Assigning Course to the learner

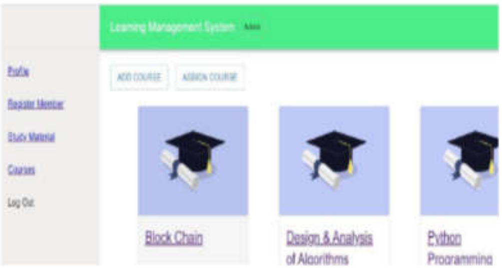


Fig. 6 List of courses inn LMS

In figure 6 all courses available for students are displayed and student has choice to join the any one of the course.

Fig 6. Admin view of the courses

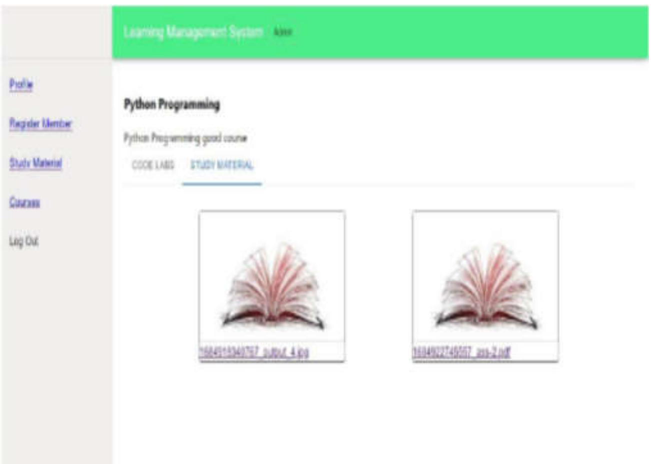


Fig. 7 Course added by admin

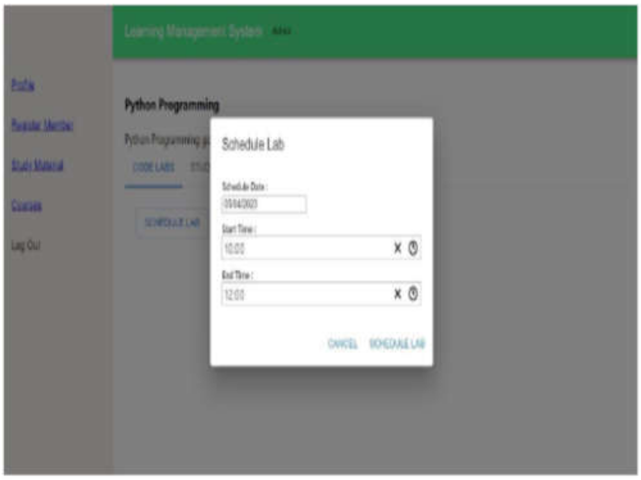


Fig. 8 Scheduling Code Labs

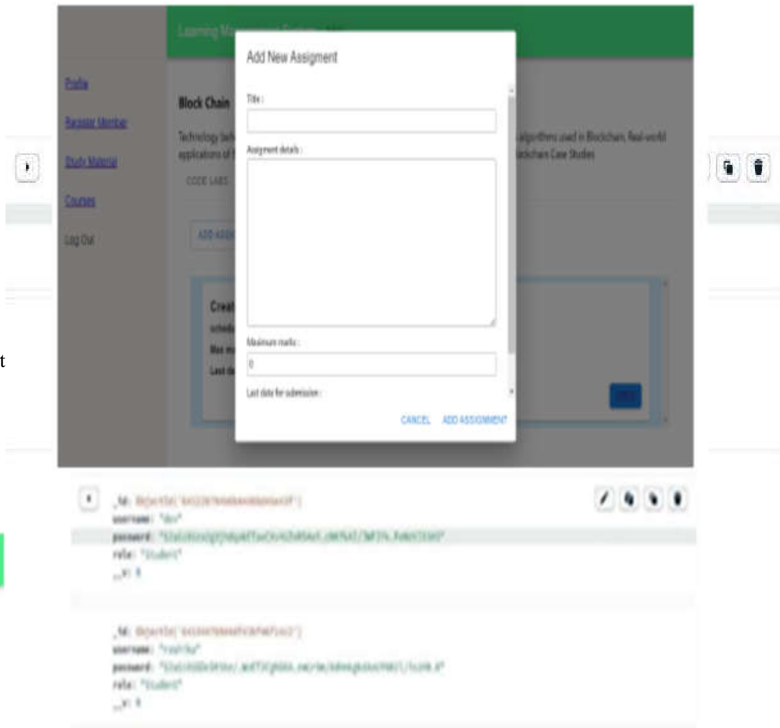


Fig. 9 Adding New Assignment

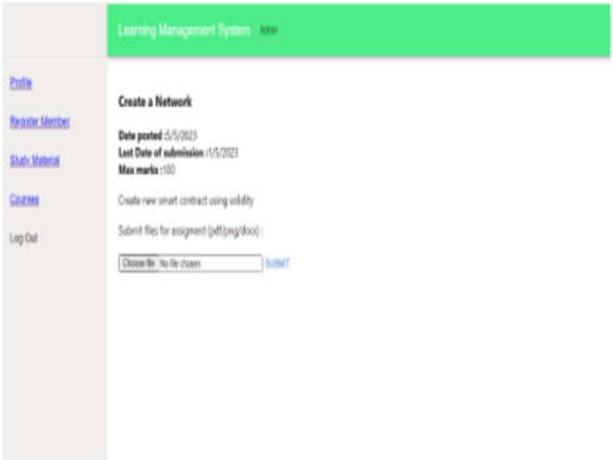


Fig. 10 Adding New Assignment

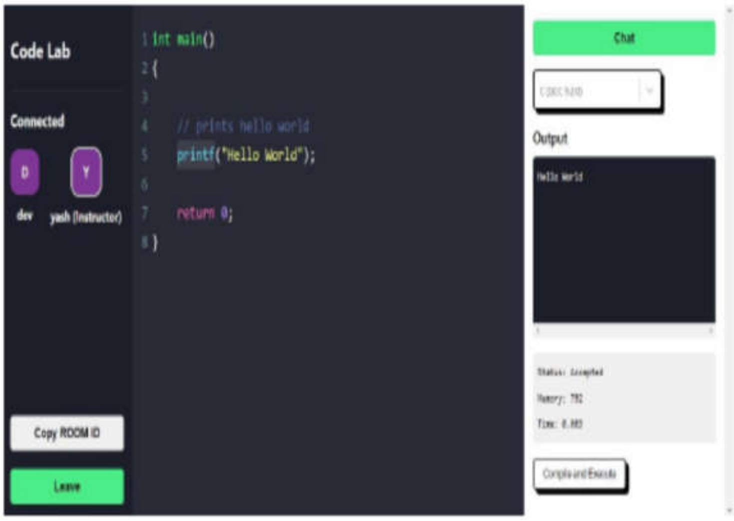


Fig. 10 Collaborative Coding Instructor and learner

Figure 11 illustrates how an instructor will be able to add a new codelab for a respective course, the instructor will enter details like lab date and duration (e.g. start and end time.) to add new documents into the codelab collection in the database.

Codelab

Figure 12 illustrates a live code lab started by an instructor and joined by students, the list of members present in the codelab will be present in the right side along with the name of each and member and tag instructor will be written under the instructor avatar.

Fig. 11 Code Lab Chat

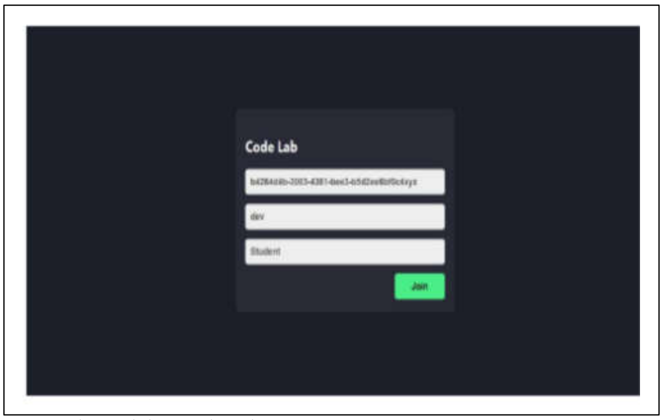


Fig. 11 Student Joining Code Labs

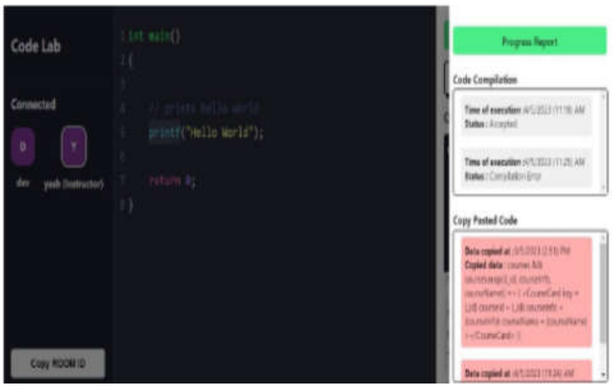


Fig. 12 Code Copy Pest Detection

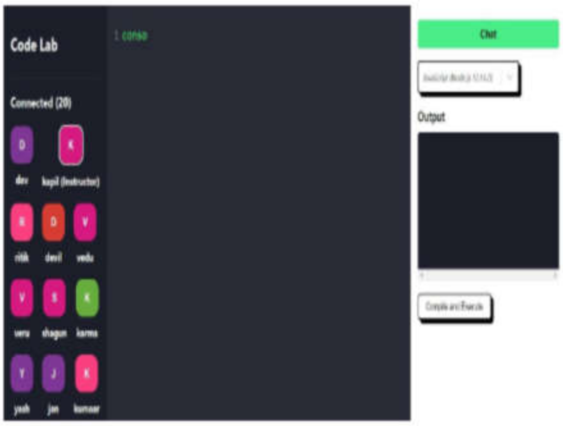


Fig. 13 Multiple users joining Code Labs

Table 2 : Impact of no of users on latency

SrNo	No Students participation	Impact (Avg. time(sec) delay in code Synchronization at Learner end)
1	1	0.012
2	5	0.012
3	10	0.012
4	15	0.09
5	20	0.1
6	25	0.1
7	30	0.13
8	35	0.135
9	50	0.149
10	100	2.10

Latency for 5 student joining code lab is found out to be 0.01s, 0.015s, 0.01s,
0.015s, 0.01s.
So the average latency while 5 student while using the code lab is
Avg Latency = (0.01s + 0.015s + 0.01s + 0.015s + 0.01s)/5
= 0.012s.
The above calculation shows the average of the latency calculated for for the first 5 students. This can further be referenced in Table 8.1, which is a representation of the average latency values upon addition of 5 students each every iteration
going from 1 student in the first row going all the way to 35 students in the 8th row.

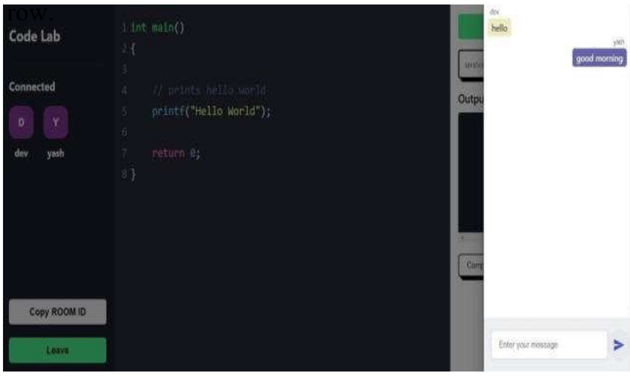
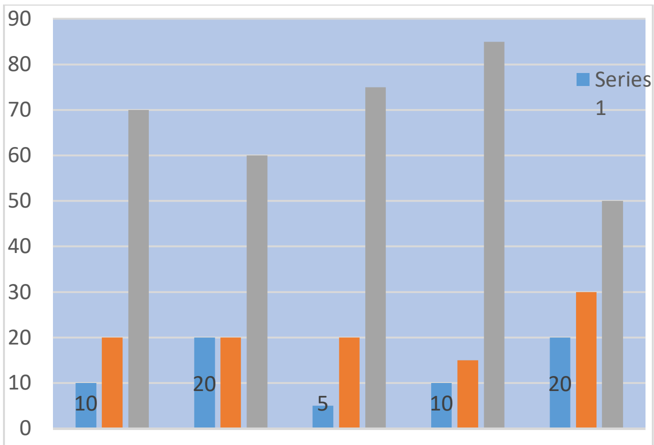


Table 3: Collaborative LMS- user feedback

Sr No	Parameter	Low	Medium	High
1	Interface	30	40	30
2	Ease of Use	10	20	70
3	Support for Programming Language	20	20	60
4	Latency delay	5	20	75
5	Collaborative coding	10	15	85
6	Version Controlling	20	30	50



VI DISCUSSIONS

The objective of this paper is to implement a collaborative Integrated Development Environment (IDE) within a Learning Management System (LMS) for online collaborative coding.

We proposed the challenges of limited interaction, instant communication, and feedback in coding sessions and assessments in a remote learning environment.

i)Real-time Progress Tracking: The collaborative IDE was anticipated to provide instructors with the ability to monitor students' development progress in real-time.

By observing students' coding activities, including code modifications, debugging sessions, and compilation issues, teachers would be able to provide prompt intervention and tailored feedback.

ii) Interactive Communication and Feedback: It was anticipated that the use of communication technologies, such as screen-sharing capabilities and real-time messaging, would promote interactive contact between teachers and students. Instructors would be able to lead interactive coding sessions, make prompt explanations, and provide rapid feedback during tests thanks to this.

iii) Learning Experience: We expected the overall learning experience to be improved by including a collaborative IDE within the LMS. A smooth coding environment would be available to students, encouraging involvement, teamwork, and engagement. Furthermore, the IDE's collaborative features would promote student knowledge sharing and peer-to-peer learning. The project's results showed that a collaborative IDE could be successfully implemented inside the LMS and were in line with the anticipated goals. With the help of the developed system, instructors were able to monitor students' coding activities in real time. This made it easier to provide prompt feedback and intervention, which led to a more engaging and customized learning environment.

By encouraging real-time engagement, communication, and feedback, the developed system has the potential to greatly enhance the learning process and close the gaps frequently seen in remote coding instruction.

VII CONCLUSION

The difficulties posed by online coding sessions and tests have been effectively resolved by the integration of a collaborative Integrated Development Environment (IDE) into a Learning Management System (LMS). According to the research, it has the potential to revolutionize remote coding instruction by facilitating interactive conversation, real-time progress monitoring, and prompt feedback between teachers and students. The collaborative IDE encourages active participation and teamwork among students by providing an easy-to-use and effective coding environment. Now, teachers can keep a close eye on their students' progress in real time and offer prompt advice and assistance.

Effective information transmission is encouraged and interactive sessions are made easier by the IDE's incorporation of communication tools. Future developments in the field of coding learning have been made possible by the research's successful implementation of this collaborative IDE. This study's application marks a major advancement in raising the caliber and efficacy of instruction in programming and coding. It gives students access to a collaborative and immersive coding environment and gives teachers the resources they need to provide effective and captivating education. The research concept propels the development of distant learning and its use in computer science education by creating exciting prospects

for more innovations and advancements in the field. Time, participant access, and financial resources are only a few of the resource restrictions that affect the research. The breadth and depth of data collecting and analysis may be impacted by these limitations.

The proficiency and skills of teachers are critical to the success of interactive coding cooperation. However, differences in teacher experiences and competences might not be fully taken into consideration in this study.

Implementing interactive code collaboration may be impacted by variations in curriculum architecture, laws, and educational systems. Although the study recognizes these distinctions, it might not go into great detail about particular institutional or geographical variations.

In conclusion, the research's scope and limits acknowledge potential shortcomings and set the study's goals in context. Although the goal of the research is to provide insightful information on how interactive coding collaboration might improve professional education, it is important to acknowledge these limitations and scope when interpreting the results and applying them to particular situations. This implementation also aims to solve the uncertainty that students have about their next skill or career route after completing a course. A skill and career prediction system will be incorporated into the platform by utilizing the data gathered from student development within the collaborative IDE. This system will use machine learning algorithms to offer students tailored recommendations for their next desired skill and possible career routes, enabling them to make well-informed decisions about their futures.

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