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1 Chapter 1

1.1 Introduction

Through the last ten years, the definition of education has been constantly changing. With emerging technology, education has been able to take various forms. Due to the unforeseen events in early 2020, all forms of education had to adapt to the online medium using distance learning platforms such as Zoom, Google meet and Microsoft Teams (Pal et al., 2021). The transition from full-time learning to distance learning is shown to produce a certain "stress" that can hamper the students' learning outcome (Zinovieva et al., 2021). Good teaching itself doesn't vary as the mediums changes but translating these teachings over to a online medium brings unique challenges (Driscoll et al., 2012).

According to a survey at Kyiv National Economic university, of the bachelor level computer science students, it was discovered that 73% of the students had problems with distance learning (Zinovieva et al., 2021). Figure 1.1 shows the most common problems the students faced. Interaction has been deemed as an essential component for online education to succeed (Driscoll et al., 2012). Figure 1.1 highlights support and consulting from teacher as the main problem among students of online education which supports the importance of interaction in an online setting.

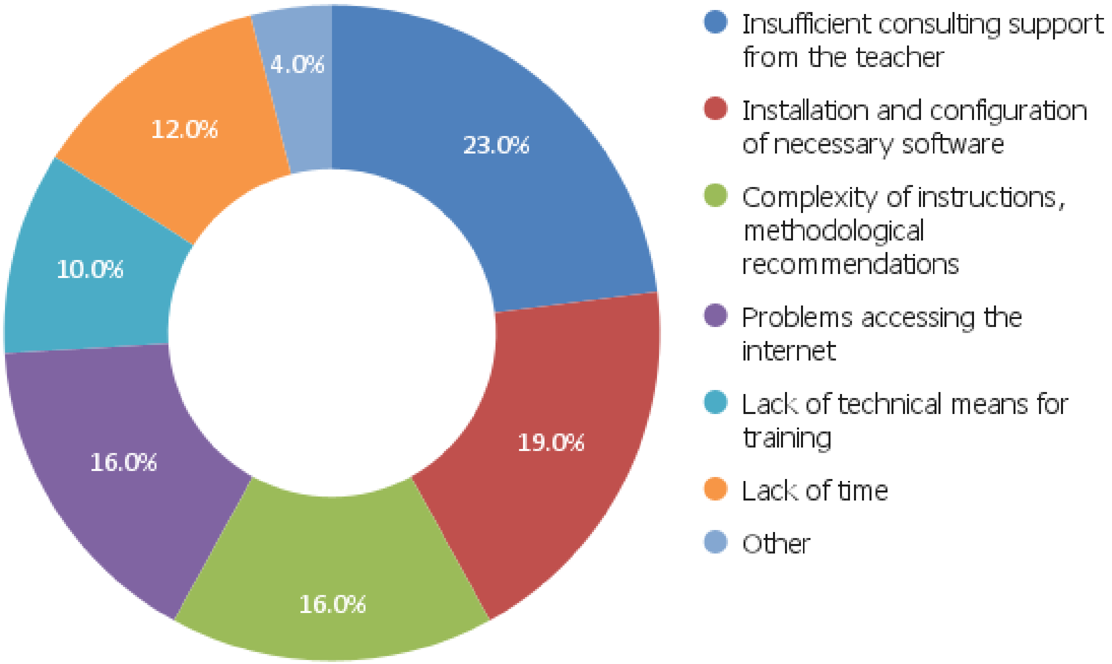

Figure 1.1: Problems faced by students of computer science during distance learning (Zinovieva et al., 2021)

Online education for programming produces outcomes worse than that of regular classes. It has been proven that students that learn programming through online education or E-learning have outcomes that lag behind students learning the same course in regular classes (Fojtik, 2017). As shown in Figure 1.1, online education for computer science brings along challenges that results into difference in outcomes against full-time students. Online education looses the spontaneous feedback between instructors and learners (Martin, 2019).

The main scope of the system will be in the online education field targeting the programming courses. There will be two users facilitated by the system, instructors and learners. It has been found that online course when designed with maximizing interaction between instructors and learners in mind can be as effective as face to face classes (Driscoll et al., 2012). Therefore, this system aims to provide a platform to learn coding online with a focus on interaction and communication between instructors and learners.

1.2 Problem Statement

- Existing applications used to learn to code online provide fewer features for real-time editing of code.
- Existing applications have fewer models for users to pass on notifications to their instructors by highlighting the point at which they encounter anomalies in their code.
- Existing application require users to install and configure necessary software before they can learn to code online.
- Fewer systems have diverse accessibility control options such as view only and can edit.

1.3 Objectives

- To create a real-time application using WebRTC and Websockets.
- To provide the feature of real-time editing that an instructor can access to solve a learner's problem.
- To make use of flags with the help of which learners can notify any problem.
- To provide a platform for learning to code without having the need to setup and configure programming environments.
- To execute the written code with Judge0 API (Application Programming Interface) and display the output.
- To create an audio channel of communication between instructors and learners.
- To include diverse control options within the system.

1.4 Scope

1.4.1 User scope

1. Users will be able to host a room where learners can join in if the user is an instructor.
2. Users will be able to communicate through text and audio interfaces.
3. Users will be able to execute code within the system.
4. Users will be able to share their code with other users in the system with varying permissions.
5. Users will be able to edit code of their learners in real time.

1.4.2 System Scope

1. System will provide users to communicate through text and audio interfaces.
2. System will allow users to share their code with others with permissions such as can edit and can view.
3. System will provide users to code online without any previous setup.
4. System will enable real time editing of code.
5. System will allow instructors to create a room for learners to join in.

1.5 Constraints

The system will use Monaco Editor as the code editor which is not supported in mobile browsers or mobile web frameworks. Access to internet itself can be a limitation to the system as it is a web application and uses UDP protocols and sockets to form the communication bridge between instructors and learners. The support for WebRTC can be a limitation to the system as it is not supported in browsers such as Internet Explorer (IE), Opera Mini and UC browser for Android (*"web Rtc " | Can I Use... Support Tables for HTML5, CSS3, Etc*, n.d.).

1.6 Methodology

Real-time features implemented with optimized resource consumption will ensure that the communication between the instructor and learner remains stable. WebSockets are known to work with better network performance and greater throughput when comparing against AJAX (Asynchronous JavaScript and XML) (Puranik et al., 2013). Therefore, the real-time editing feature will be implemented using WebSockets through socket.io library and the communication channel with the audio interface will be implemented through WebRTC (Web Real-Time Communication) using the UDP protocol (User Datagram Protocol). This application will make use of an event-driven programming paradigm as every change made in a user's editor will trigger an event that can be broadcasted with the help of WebSockets using Socket.IO. The project will be using a signaling server to initiate a connection between the users while the real-time data exchange for communication will be done through peer-to-peer communication through WebRTC.

1.7 Development tools

The development tools to be used in the system are as follows:

1. Socket.IO library: This library provides higher level API (Application Programming Interface) to work with WebSockets. This library will be used to facilitate real time editing of code by broadcasting the changes made in the Monaco editor.
2. NestJS: It is a framework for building scalable server-side Node.js application. The project will use this framework to create the back-end and its API.
3. Next.js: It is a React framework that allows users to choose between Server Side Rendered (SSR) or Static Site Generation (SSG) strategy on a per page basis. The project will use this framework for creating the user interface of the system.
4. Monaco editor: This library provides a text editor similar to that of Visual Studio Code for the web. The project will use this library to create text editor for users to write code in and the library also provides events for when the code written changes which can be used to broadcast the changes for real time editing feature.
5. PeerJS: This library is a higher level wrapper over the WebRTC API that simplifies peer-to-peer (P2P) data, video and audio calls. The project will use this library to establish the P2P connection between the users for text and audio communication.

1.8 Structure of Report

The structure of report outlines the entire format of the paper. The paper consists of six chapters and the contents of the chapters are described below:

1. Chapter 1: This chapter gives a brief outline about the methodology used in the system, and gives description about the problem and objective the project is trying to achieve.

2. Chapter 2: This chapter provides review about the literature that has already been written in the related field of the paper topic.
3. Chapter 3: This chapter gives detailed description about the methodology used to achieve the paper's objective and the different software tools and the reasons behind using the said tools.

1.9 Conclusion

There exist a gap between distance learners and face-to-face learners specially in terms of programming subjects (Fojtik, 2017). It has also been proven that interaction plays a major role in success of distance learning (Driscoll et al., 2012). Taking this problem into consideration this project aims to facilitate better communication between instructors and learners in the context of learning to code online. The project will provide real-time interaction using WebSockets and communication channel with audio interface through WebRTC.

2 Chapter 2

2.1 Introduction

Education in virtual classroom requires higher effort to remain motivated to learn when compared to a face-to-face classroom (Mihai, 2014). This paper highlights that due to the lack of real presence of learners, instructors in virtual classroom require more effort to gather attention of learners. This problem is present in online education of every study but it is amplified in the field of studies that emphasizes more on practical aspects like computer science (Zinovieva et al., 2021). The author also presents that the transition to online education from a face-to-face lecture further distances students from the course, their peers and teachers ultimately introducing a certain "stress" that affects their learning. It has been noted that the presence of a community and its support is essential to maintain students' engagement in virtual education programs (Berry, 2017; Rovai, 2003). Past literature have defined community as a social group that is credited to managing stress and decreasing isolation (Pyhältö et al., 2009; Stubb et al., 2011; Berry, 2017). Emphasis on building a community gives rise to a collaborative learning process. It has been proven that collaborative learning provides benefits over individual learning (Nokes-Malach et al., 2015). Collaborative learning enables communication between peers, discussion of ideas and the opportunity to question and exchange ideas which motivates learners to be active (Laal, 2013). This collaborative learning will be focused on this system through the use of audio and text communication with real-time editing features that will encourage students to take direct feedback from their peers and their teachers.

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