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IMPACT OF TEACHING AND LEARNING CODING IN STUDENTS' LIFE - AN EMPIRICAL STUDY

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Abstract: Coding is the process of human interaction with computers, which deals with ideas, solutions, and instructions into a language that the computer can understand. This article focuses on the in-depth study of coding, coding tools, the design of the coding curriculum, the online method of teaching and learning coding, and its impact on student's life. An empirical study was performed on teaching and learning visual tools, like scratch, code.org, repl.it, thunkable, and python to code through a one-on-one approach. A case study was used as a method in this research. This study was performed through Codingal company on teaching and learning middle school students from various countries through an online mode. Qualitative and quantitative approaches were used to collect data to analyze. The study found that learning coding on a one-on-one approach creates instant gratification in students and helps them to enhance core competencies like logic development, critical thinking, design thinking, creativity, algorithm, abstraction, real-world application, communication, and collaboration on students throughout their coding journey.

Keywords: Coding, One-on-one learning, Coding curriculum, Middle school students.

Resumo: A codificação é o processo de interação humana com o computador, que lida com ideias, soluções e instruções em uma linguagem que o computador possa entender. Este artigo se concentra no estudo aprofundado de codificação, ferramentas de codificação, design do currículo de codificação, método online de ensino e aprendizagem de codificação e seu impacto na vida do aluno. Foi realizado um estudo empírico sobre o ensino e aprendizagem de ferramentas visuais, como scratch, code.org, repl.it, thunkable e python to code através de uma abordagem individual. O estudo de caso foi utilizado como método nesta pesquisa. Este estudo foi realizado através da empresa Codingal no ensino e aprendizagem de alunos do ensino médio de vários países por meio de um modo online. Ferramentas qualitativas e quantitativas foram usadas para coletar e analisar dados. O estudo descobriu que a aprendizagem de codificação em uma abordagem individual cria gratificação instantânea nos alunos e os ajuda a aprimorar competências essenciais, como desenvolvimento lógico, pensamento crítico, pensamento de design, criatividade, algoritmo, abstração, aplicação no mundo real, comunicação , e colaboração com os alunos ao longo de sua jornada de codificação.

Palavras-chave: Codificação, Aprendizagem individual, Currículo de codificação, Alunos do ensino médio.

The internet and cloud computing are becoming more advanced, and there is a significant development in editors and Integrated Development Environments (IDEs) that can be used online. So, giving opportunities for students to learn about technology and how the computers work will surely give them advantages in their life. Learning to code at the young age will set them up for a successful future (Bonfligo, 2018). The research study was carried out to understand coding, coding tools, design of coding curriculum, online method of teaching and learning coding, and its impact on student's life. A case study was used as a method in this research. An initial study was performed to analyze the corporate companies, which offer the courses on coding.

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The corporate companies like udemy, codingal, skillcrush, codecademy offer online coding for beginners to complete the interactive elements of the course with minimum requirements that the students need a desktop or laptop computer with an internet connection. They give promises like “Become a Coder, have fun, and learn one of the most employers requested skills for 2022!” (Udemy, 2021), “Online coding classes for kids to become the innovators of the future” (Codingal, 2022), “Code your way to a more fulfilling and higher paying career in tech” (skillcrush, 2022), “Join the millions learning to code with Codecademy for free” (codecademy, 2022), etc.

Seeing such advertisements, motivated me to apply for the vacancy in the Codingal company for the post of a computer science teacher. I was elected through an interview and they provided training for the course. The training was focused on “Teacher on-boarding for 6-8 Grades” with topics like becoming a part of codingal team, curriculum, and workflow, day-to-day tasks, effective sessions and guidelines, and activities on different platforms like scratch, code.org, repl.it, and thunkable, quality assurance in education, all about course classes, mock on trial class preparation and curriculum mocks. The training was planned and conducted systematically, ensuring that the candidates should learn and understand the topics by scoring a minimum of 80 percent marks in all quiz activities. I was awarded a certificate as a coding instructor by the Codingal company for grades 6-8. The opportunity helped me to do an in-depth study of the curriculum. The curriculum is designed in line with the design principles of the National Education Policy of 2020 such as identifying, and fostering the unique capabilities of each student and encouraging logical decision-making and innovation through creativity and critical thinking (Government of India, 2020). This enabled me to teach the students in trial and course classes about coding and observe their performances in their activities.

Qualitative and quantitative methods were used to collect the data. The method of teaching and learning coding was focused on the one-on-one online mode in the form of one instructor with one student. The course classes were conducted by the procedures given by the codingal company. The instructors should welcome and congratulate the parents and students for joining the course, introduce the platform that the student going to learn, follow quality assurance in teaching, make the student to perform the activity and submit the same, then discuss after-class projects. Collect verbal feedback from the student and appreciate him/her for the activity and encourage the student to fill the feedback form at the end of the session. At the same time the instructor should fill the performance of the student in the session.

METHODOLOGY

A case study was used as a method in this research, and the study was carried out from 6th July 2022 onwards. The training from the codingal company enabled for me to conduct a qualitative research approach as an exploratory way for learning and understanding the concepts of coding and coding tools as stated below.

CODING

Coding is the process of transforming ideas, solutions, and instructions into a language that the computer can understand (Lemonaki, 2021). Coding helps us to communicate and give commands to the computer to perform different actions using a computer programming language. Block-based coding is the entry-level for beginners, which enable them to drag and drop the blocks into the input field. Students can use blocks to construct animated stories and games, where they gain a foundation in computational thinking (Rayan, 2020). Text-based coding involves writing lines of code, which is an essential way of typing instructions in a programming language following a syntax. Syntax is a set of rules in a programming language.

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CODING CURRICULUM

The curriculum was designed based on holistic learning and a personalized method, which is integrated with Blooms' Taxonomy, BIDE (Broad, Inspiring, Deep & Efficient), and STEAM ((Science, Technology, Engineering, Arts & Maths). It focuses on Blooms Taxonomy with a standard guideline for K-12 content development, which includes six stages of learning: remember, understand, apply, analyze, evaluate, and create. Codingal company developed the BIDE model to make the curriculum to cater for the unique learning abilities of each student. Codingal got accreditation from STEAM learning methodology, which helps to connect their daily learnings with technology (Codingal, 2022).

According to Coding Courses (2023), the curriculum was well designed with courses like Rising Coding Star, which allows students to step into the world of coding to learn basics, create games, websites, and more. It includes 20 lessons and 60 + activities. The course Coding Champion allows students to advance their coding skills and build a deeper understanding of complex coding concepts. It has 50 lessons and 100 + activities. Course Coding Prodigy allows students to excel at coding and building amazing websites, games, and apps. It has 98 lessons and 184+ activities. The ideal course Coding Grandmaster allows students to master the art of coding and create a better future through code. It has 158 lessons and 450+ activities. Even students can choose specialized coding courses like Scratch Programming, Python for Kids, Game Development, Web Development, App Development, Data Science, and Roblox. It is also designed well with modules, lessons, and activities.

CODING TOOLS

SCRATCH

Scratch is a block-based coding language with a simple visual interface, which allows students to create digital stories, games, and animations. It promotes computational thinking and problem-solving skills, creative teaching and learning, self-expression and collaboration, and equity in computing (Scratch Foundation, 2022). Scratch has its own paint editor and sound builder, which enable students to create their own sprites and sounds. Scratch codes are made up of graphical colored blocks that allow students to drag and drop to create programs by joining different code blocks. The blocks are similar to puzzle pieces that can be joined to make sense by avoiding invalid combinations. Scratch is designed to meet the needs of the students in the age groups of 8 to 16 in developing their learning capabilities and opportunities for creativity using block-based coding (Reddy, 2021). It is a charge free coding platform for students to create projects and they can share them with others.

CODE.ORG

Code.org is an education innovation non-profit with a goal of driving more interest in computer science and making it available in schools for more students' participation. It operates the learning platform, which powers Code.org courses in hundreds of thousands of classrooms around the world (Code.org, 2022). The vision of Code.org is that every student in every school should have the opportunity to learn computer science, and computer programming and it should be part of the core curriculum in education. Code.org is an instant gratification for students, which allows them to click and drag the blocks to create an instant project (Mower, 2019). Code.org picked the Amazon Web Services (AWS) Cloud to run its website, learning platform, and the Hour of Code, because it offers the right combination of scalability, reliability, flexibility, and security (Code.org, 2022).

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REPL.IT

REPL stands for Read-Eval-Print-Loop. It is a programming environment, which provides for interactive coding using a large number of programming languages (Jones, 2021). Repl.it is an IDE (Integrated development environment) which works within the web browser. The interface has two main areas, an editor and a console, which allows both developers and educators for coding in a variety of programming languages. It supports 50+ programming languages, which includes Python, C, C#, Node.js, Basic, and Machine Assembly, and also it allows us to write, run, and host HTML, CSS, and JavaScript webpage code.

THUNKABLE

Thunkable is a web-based application, which uses a visual programming concept with a drag-and-drop approach (Sari, 2022). It is easy to understand for creating a cell phone-based application. It is a non-code platform, which is an essential characteristic of mobile apps. Thunkable supports any operating system without writing a single line of code.

PYTHON

Python is a programming language that lets us work quickly and integrate systems more effectively (Python, 2022). It is highly versatile and can be used for both small and complex tasks. Python has more common applications in data science and software engineering to environments like mobile app development, artificial intelligence, and machine learning (Why Learn Python, 2023).

ONLINE TEACHING AND LEARNING CODING

Codingal has designed and offered courses based on the student's grades, and the students can book a trial class to get exposure to online coding sessions for an hour. From all over the world 143 students registered for the trial classes but only 49 students attended. The study was conducted on 49 students, who had attended the trial class from different countries like Azerbaijan, Belize, Egypt, Ethiopia, Germany, Ghana, Greece, Guyana, India, Iran, Jordan, Kenya, Maldives, Morocco, Namibia, Nepal, Nigeria, North America, Papua New Guinea, Rwanda, Sierra Leone, South Africa, and Zambia.

Attending a trial class, students must have a laptop or a desktop with a minimum configuration of 8 GB RAM, an operating system of Windows 10, and an internet speed of 15Mbps. When the student joins the trial class, the instructor welcomes the student and parent by wishing them and asking their names and the country they belong to. The instructor will give a brief introduction about the trial class and ask the student's parent to join the session if they are interested so that they can observe the performance of their son/daughter during the session. To understand the student's background knowledge about coding, the instructor will ask and explain the concept of coding. Based on the student's knowledge about coding, the instructor will choose two game activities and show it to the student. The student can select any one of the activities based on his/her interest. The selected activity will be explained by screen sharing option, which will allow the student to view the instructor's screen. At the same time, the instructor can view the student virtually by enabling the picture-to-picture option while presenting.

The instructor will instruct briefly about the interface and explain the block-based coding in a step-by-step process. Once the coding is explained, the student has to do the same activity by sharing the screen and activating the picture-to-picture option, which enables the student to view and listen to the instructor while performing the activity. After completing the activity, the student needs to save the file and submit it as a project on the codingal site. Once the student submits the activity, the student receives applauses with a congratulatory message, then the instructor asks

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the student to call his/her parents to brief them about the courses offered by the codingal. This will allow the student and their parents to decide to register for the course classes. At the end of the session, students need to give feedback about the session on a scale of 1 to 5 stars.

The students' feedback and the session of observation enabled me to perform a quantitative research approach to analyze their performance and their understanding of learning coding through trial classes. Gamification concepts were implemented in teaching and learning coding in codingal, as well as points, badges, and leaderboard were used to hold students' and teachers' attention in teaching and learning coding. Motivation is a key component of successful learning, without the proper incentives, students can get bored and abandon learning coding before they've become proficient (Choi, 2022). Below is the chart of student's performance in one-on-one sessions of trial classes.

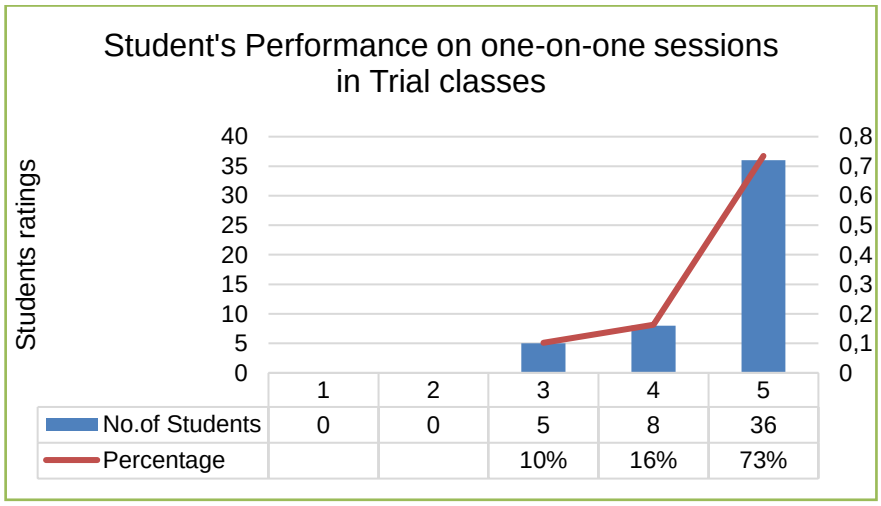

CHART 1: STUDENT'S PERFORMANCE IN TRAIL CLASSES

143 students registered for the trial classes, and only 49 students participated in the trial class. Students who attended the trial class rated their views on a scale of 1 to 5, which indicates low to high value. 10 percent of students rated 3 on a scale of 1 to 5, this was observed during their sessions that they attended the sessions through mobile phones and tabs, which won't support performing the activities given in the trial session.

16 percent of students rated 4 on a scale of 1 to 5, during the sessions it was observed that they had technical challenges with camera, microphone, and unstable internet connection. However, the system supported them to use the chat window for communication, which ended up partial completion of the session.

73 percent of students rated 5 on a scale of 1 to 5, which shows that students were able to achieve the effectiveness of one-on-one online trial sessions through the following breakups of the session.

Brief introduction about the trial class with a duration of 3 minutes, which will enable the teacher to set up the mood of the class by impressing the parent and the student with his/her vibrant personality like smiling, chirpy, enthusiasm, and making them session more interested.

Interaction with the parents within 3 minutes by introducing the teacher's skills and achievements creates positive thinking and motivates them to stay throughout the session and see how and what is taught in the session. Moreover, we can get the parent's

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impression and their valuable advice, suggestions, and their expectations about the session.

Rapport building is a process done by the teacher for 9 minutes to build a good, cordial, and friendly relationship with the student.

The trial class activity has to be conducted for 30 minutes by defining the purpose of the projects, to make them understand how to create the projects by coding, and how to get the outcome of the projects. Students can select any one project out of the three and can create the selected project by themselves with the guidance of the teacher. During the activity, the teacher can engage the student through physical actions like asking for a Hi-five or clapping for yourself whenever the student does something good in the activity. After completion of the project, students submit the project and get applauses for his/her achievement.

Parent interaction will be done after the student completes the project within the given duration of 15 minutes. The teacher asks the student to explain the activity first and asks him/her a few questions to cheer the parents on the good performance of their kid. Later the teacher will discuss and explain the company codingal and the curriculum offered for the course classes.

A buffer time of 15 minutes is given in the session. It is ideal for the teacher to end the session before the buffer time. Teachers can use the buffer time to fill up the feedback form for the student and upload the session recording, or even the teacher can take a rest. Teachers can extend the trial class if the class starts a bit late, or she/he has some technical glitches by which session time was wasted.

Only 5 students enrolled for the course classes out of 49 students who had attended the trial class sessions. The student's timetable was planned and set according to the teacher's availability slots in the teacher's calendar. Students had two to three sessions per week.

Students who had enrolled for course classes have modules like M1- Scratch Intermediate, M2 – Scratch Advance M3 - Scratch Specialization, M4 – Artificial Intelligence 1, M5 – Advance Artificial Intelligence, M6 – Thunkable Basic II, M7 – Thunkable Intermediate 1, M8 – Thunkable Intermediate II, M9 – Thunkable Advance 1, M10 – Thunkable Advance II, etc. During the course class, if the student has any internet connection issues, then the teacher can reschedule the session within the scheduled time, which has to be followed by the student. If the teacher cannot complete the session within the time limit due to any technical glitches, the teacher can utilize the buffer time of 15 minutes to complete the session.

On every successful completion of a course class session, the students and the teachers will get 50 points each, and it was observed that the student's feedback on a scale of 1 to 5 stars will reflect in the teachers' performance in the form of points. If the student rated the session with 4 or 5 stars then the teacher will be awarded 100 points, otherwise, the teacher will be awarded minus 200 points. The teacher should provide feedback for every student at the end of the session for the following questions.

Rate the content/lesson/activity on a scale of 1 to 5 stars.
Was the lesson plan good enough to understand the lesson? Yes/No
Share a detailed performance review of the student in today's class.
Rate the kid's performance in today's session on a scale of 1 to 5 stars.
Areas of improvement for the student.
Was the session content appropriate for 1 hour? Yes/No
Students' reaction to the lesson, with options Too Easy, Easy, Medium, Hard, and Very Hard.

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Upon completion of every module, teachers should give feedback about the performance of the student through slides and conduct Parents Teachers Meeting (PTM). This enables teacher to interact with parents to discuss about student's performance with respect to the course classes. The teacher uses a sandwich method form of feedback which goes like GOOD-BAD-GOOD, starting with praising the student and talking about all the good progress he/she has made and then adding points of improvement in a constructive way, which shows that the teacher has put in the effort and concerned about the student's progress.

Students have a leaderboard similar to teachers and they get points for every activity they perform during the course class as shown below.

+20 points for attending classes
+100 points for submitting the project on time
+ 50 points for submitting the project after the due date
+100 points for submitting the Quiz on time
+50 points for submitting the Quiz after the due date
-15 points for rescheduling a class at least 1 hour before the start time
-50 points for rescheduling a class within 1 hour of start time
-100 points for not showing up for a class.

These points motivate students to attend the course class sessions and make them complete the tasks on time.

Codingal used the concept of gamification, it is the idea of adding game elements like points, badges, and leaderboards to a non-game context which enables students to have fun. Gamification in education can enhance levels of students' engagement similar to what games can do, it improves their particular skills and optimizes their learning (Smiderle et al., 2020). The most popular gamification elements used during computer science classes were points, badges, leaderboards, levels, and feedback (Yazdeen & Özdamlı, 2021). Below are the game elements that are used in the codingal courses.

POINTS – Students earn points by attending the session and submitting their after-class projects. Even teachers will gain points by completing the session and marking the after-class projects. 88% of students stated that they feel boosted by the motivation of game points for accomplishing certain tasks and they are being engaged in the activity (Lawrance et al., 2021).

BADGES – According to (Galessi, 2018) badges are simple virtual ribbons, which illustrate a certain capability for users to do something. It is essential for users to feel they are important and skilled. Badges are awarded to students as they reach the goal by collecting a certain number of points in each session. Badges symbolize a reward given to the students for their achievements. They create positive reinforcement in students' behavior and drive them to take the initiative to gain the most out of the sessions.

LEADERBOARD – It will enable students and teachers to know their positions based on their achievements in their activities which will be displayed in the leaderboard. It is a running score, which shows the results of students and teachers according to their performance. This kind of competition can act as motivation and enthusiasm for students and teachers. 75% of students mentioned Leaderboard is one of the major boosting factors in Gamification tools (Lawrance et al., 2021).

LEVELS – According to Duggan (2021) levels serve two important roles in gamification, they indicate the progress of players from one level to the next level by giving a sense of satisfaction and they convey the status of the player who has reached the final level as considered more expert than someone who has failed in the first level. Levels enable students and teachers to continue to build on the concepts in the module, as they complete the concept, and they get access to the next content. Students and teachers progress through different learning levels as

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they complete each content and course and ultimately reach the zenith, it also indicates the achievement of the student and the teacher.

FEEDBACK – It is very essential for students and teachers to get feedback, which will enable them to improve their performances. In Codingal, during the session the student will get immediate feedback from the teacher based on the session interactions. Apart from this, the students and the teachers need to give feedback at the end of their each session, which will reflect as points for the students and the teachers on their respective dashboards. Every teacher will also get feedback from the Quality Assurance Department of Codingal, based on the submitted session videos, which will help the teacher to improve their sessions.

Out of 5 students, who joined the course class only 4 of them regularly attended the course class sessions, one student had a challenge with his internet connection, and most of the time he was disturbed by breaking signals and ended up with one-way communication. 63-course class sessions were conducted in 8 percent of sessions rated by 3 on a scale of 1 to 5. These ratings were observed and found that the student who had a poor internet connection rated 3 on the of scale of 1 to 5. This was informed to the parent of the student and requested to increase the bandwidth of the internet connection, but due to some personal challenges the student was unable to upgrade the internet connection and later the student discontinued the course class. The chart below shows details of students who attended the course classes.

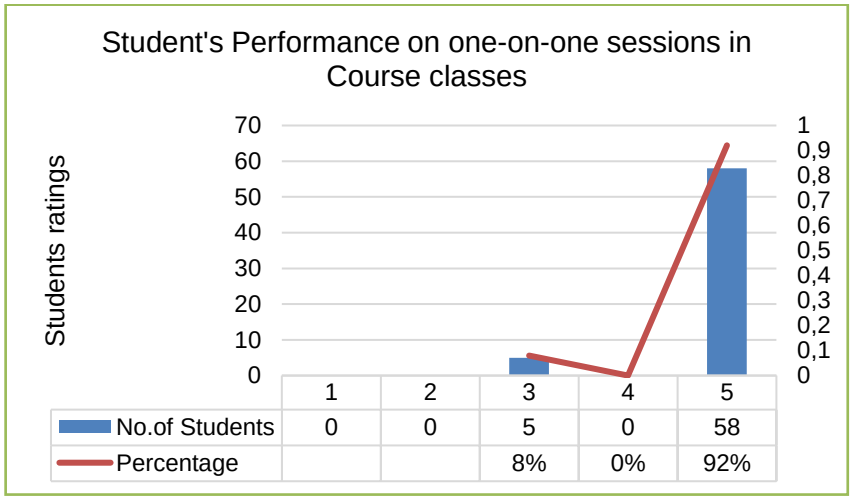

CHART 2: STUDENTS PERFORMANCE ON COURSE CLASSES

92 percent of sessions rated with 5 on a scale of 1 to 5, which shows the lowest to the highest. This shows that the students who attended the sessions were able to understand the coding concepts and perform the tasks in a specified time. Every module in the course class was focused on learning objectives to build a deeper understanding of complex coding skills and build complex games and applications. Students develop key skills in activities like event handling, performing conditional statements, repeating tasks through loops, declaring variables to assign values, using operators to perform various calculations, functions to perform specific tasks, transferring controls based on logic, drawing shapes or characters to animate, etc.

The students gain instant gratification by doing the activities in each session. The students enhance core competencies like logic thinking, critical thinking, design thinking, creativity, problem-solving, algorithm, abstraction, real-world application, communication, and collaboration on students throughout their coding journey.

Logical thinking can be defined as the act of analyzing a situation and coming up with a sensible solution (Yüksel & Bülbül, 2011). It was observed in the sessions that the students use conditional statements to perform their own set of instructions to achieve their goals. One of the

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cognitive skills that influence the academic success of students is the logical thinking ability, it refers to an individual's ability to solve a problem by using mental operations or his/her ability to reach principles or rules by making certain generalizations or abstractions (Yüksel & Bülbül, 2011).

Critical thinking occurs when students analyze, evaluate, interpret, or synthesize information and apply creative thought to form an argument, solve a problem, or reach a conclusion (Iyer, 2019). Students' creative thoughts were reflected in after-class projects, they understood the existing activity and applied their creative thoughts to develop a new application.

Design thinking is a solution-based technique to solve a problem by creating a process that engages a person in opportunities to understand the user needs, identify/re-define problems, brainstorm ideas, and finally test these ideas using prototypes to learn and iterate towards the best solution (Singla, 2020). Students developed game activities using the concept of design thinking, and platforms like Scratch and Thunkable enabled them to quickly test their ideas and iterate codes for the best outcomes.

Coding is a process of solving a problem, which helps students analyze a situation or a goal and then use problem-solving skills to determine and implement a solution. Learning to code supports students in gaining problem-solving skills by using computational thinking, which is a strategic problem-solving process by breaks down complex problems into smaller manageable pieces and it follows a set of processes to create an algorithmic solution (Team, 2022). Problem-solving skills help students to determine why an issue is happening and how to resolve that issue. Problem-solving is considered a soft skill (a personal strength) rather than a hard skill that's learned through education or training (Doyle, 2020). Learning coding enabled students to develop problem-solving skills, which was reflected in their after-class projects. The after-class projects enabled students to convey their ideas and information through visual communication using visual elements like typography, drawings, graphic design, illustrations, and animations.

As the teaching and learning in coding class is one-on-one, which enables the teacher and the student to develop a healthy relationship with each other. One-on-one sessions provided more interaction with fewer distractions, which allows students and teachers to engage actively in the session of the learning environment. However, the Coding curriculum was well set for the teacher to take the sessions effectively, and the students gained high-quality interactions with the teacher. This makes the students learn actively by collaborating with the teacher to solve problems, reframing their ideas, listening to other viewpoints, and articulating their points.

CONCLUSION

The research study was carried out to understand coding, coding tools, coding curriculum, and online methods of teaching and learning coding. The study shows that the course framework of online teaching and learning coding is well designed by the codingal company by integrating cloud-based interactive tools and gamified course activities. The study found that learning coding on a one-on-one approach creates instant gratification in students and helps them to enhance core competencies like logic development, critical thinking, design thinking, creativity, algorithm, abstraction, real-world application, communication, and collaboration on students throughout their coding journey. Throughout the study, it was observed if any technical glitches occur during the session, it will affect the session.

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