COMPUTATIONAL THINKING AND AI CODING FOR KIDS TO DEVELOP DIGITAL LITERACY

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ABSTRACT

21st-century skill development is a challenge to today`s educational system. Our rapidly transforming world with fast paced technological advancements poses different challenges. One such challenge is 21st- century skill development to meet the needs of future work force. In our research article, we have showcased that how we can develop coding and computational thinking skills in young learners at early school age. Additionally, we presented a study focusing on the significance and need of developing digital literacy. In our research work, we have also discussed the initiatives taken by different countries at the K- 12 level mentioned in the literature. The main goal of the study is to encourage educators and managers of education to take holistic initiatives to promote ICT skill development at the K-12 level to prepare a skilled future workforce.

KEYWORDS

Digital literacy, Computational thinking, Coding, 21st-century skills, digital learning process, analytical thinking, ICT education

1. INTRODUCTION

With the advent of 21st-century, the world is seeing revolution of technology embracing automation and digitalization. Artificial intelligence, advanced wireless technologies, and the Internet of Things have already transformed our world. Our future will be autonomous based on the smart environments and intelligent machines. In future, we will be not only facing job replacements by machines, but also the shortage of an advanced skilful workforce. If we failed to address this challenge, we would be facing a gap between technology advancement and skilled future work force development. This gap would be widened if the educational system failed to embrace digital literacy and the development of 21st-century skills in ICT/coding education along with reading, writing, and the mathematics skills.

The Organisation for Economic Co-operation and Development (OECD) has presented a framework for 21st-century skills [1] and identified three dimensions: information, communication and ethics, and social impact. The framework clearly emphasizes on ICT education under the communication dimension to deliver critical thinking, computational thinking, problem-solving approach, and innovation, and creation skills for the future (OECD Paper). Partnership of 21st-century learning (P21) as shown in Figure 1 in also published a framework for 21st century skills and identified ICT, technology, media, and communication education as one of the important set of competencies to deliver skills like creativity and innovation, critical thinking and problem-solving, communication and collaboration. European Union`s digital competence framework for citizens emphasizes on the adoption of digital literacy for its citizens to prepare themselves to meet the challenges of future digital economies and make

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themselves proficient in the use of technology and digital innovation and creation.

EU`s DigComp 2.0 [2] identified the main digital competencies in its conceptual reference model. These competencies are information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving.

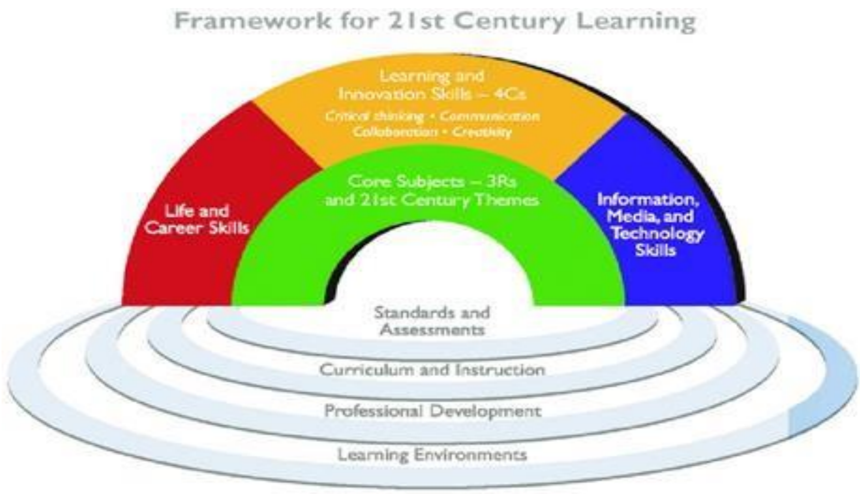

Figure 1. Framework for 21st Century Learning [1]

We need trained teachers and advanced pedagogies to achieve the goal of ICT literacy goal at the school education level. In this research work our main focus is young learners and we discuss here in detail the significance and need of coding and ICT education, pedagogical methods applied to develop ICT literacy at different levels, and initiatives taken at the K-12 level mentioned in literature. Additionally, our work presents a case study of online coding courses for learners aged 8-18. This research work is distributed in such a way that after introduction the paper presents an overview of ICT literacy and skills. The paper then sheds light on the ICT literacy initiatives at the K-12 education level. Our work then presents the case study of an online coding course for kids aged 8-18 years old learners. Finally, we concluded our paper.

2. Digital Literacy And Digital Environment 21st Century Competencies

ICT literacy or digital literacy is not just a capability of acquiring technical skills rather it's a whole educational process that encompasses a whole digital environment consisting of users, machines, tools, applications, technologies, and data. Therefore, we define ICT/ digital literacy as: "A capability of interacting within a digital environment to collect, use, create and secure information. Whereas a digital environment encompasses users, machines, tools, applications, technologies, and data." Digital literacy is also defined as the ability to understand, analyse, and use information in different forms from different sources [3].

To achieve a capability of interaction in the digital environment, there are a set of skills or cognitive competencies that should be developed [4]. Digital literacy is the combination of cognitive and technical skills as shown in Table 1 (skills). Such cognitive skills or competencies are critical thinking, problem-solving skill, computational thinking, idea creation, collaboration, and communication. The set of these technical skills includes hardware knowledge, software applications knowledge, networking, coding/programming, and knowledge from architecture design to software application development.

Table 1. Digital Literacy Skills.

Cognitive skills	Technical skills
Critical Thinking	Hardware Knowledge
Problem Solving Skill	Software Application Knowledge
Computational Thinking	Networking
Idea Creation	Coding and Programming
Collaboration	Architecture Design
Communication	Software Application Development
Ethics and Digital Awareness	Cybersecurity awareness, Skills to avoid cyber attacks

We foresee digital literacy skills will be the cornerstone of the 21st-century skills for a knowledge society where the industry will be run by automation and disruptive technologies. Thus, in future, there will be a high demand of a digitally literate workforce with outstanding aptitude for cognitive and technical skills. On the other hand, knowledge economies driven by a skilled workforce will improve life and uplift the development of society. In order to achieve a progressing economy, we need to turn our economies into knowledge economies based on digital literacy.

2.1. Digital Environment (Dig Env.)

The Fourth industrial revolution is bringing autonomous systems based on a connected world with high-speed wireless communication and data-driven disruptive technologies. Computers have already made their place in our daily lives and mobiles are everywhere. In that scenario, we define a digital environment as, "A physical or virtual place encompasses users (machines or humans), machines, tools, applications, technologies, and data." The Digital environment serves as a place for digital interaction that leads to the collection, usage, creation, and storage of information. Therefore, to operate in a digital environment, one must be digitally literate. In the future, the fourth-generation industrial revolution will roll out autonomous systems where humans will work with machines. To be eligible to work in such a mechanized digital environment, today`s learners should be well-prepared and digitally well-literate to be the part of the future workforce. 21st-century skills focus on the development of digital skills along with other skills.

2.2. 21st-Century Competencies And Digital Literacy

Different frameworks for 21st-century skills are presented by different world-renowned organisations. The Partnership for 21st Century Skills (P21), the Organization of Economic Cooperation and Development (OECD), the European Union (EU), and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) [5] have recommended ICT literacy as the core competence of 21st-century skills framework. These organisations have consistently emphasized on integration of ICT in the curriculum and the adoption of digital tools in teaching and assessment of these skills [6]. It is also noted that 21st-century skill development requires competent and well-prepared teachers to deliver the task, therefore teacher training must be part of the whole process [7]. 21st-century skill framework presented by P21 has three main groups of skills, one group of skills is "Life and career skills", the second is "Learning and innovation skills", and the third one is "Information, media and technology skills" as shown in figure 1. Digital literacy is a means to develop learning and innovation skills which finally leads to life and career skills. From literature, we find how different countries and nations are preparing their future workforce by taking mathematical and digital learning initiatives to embrace next generation`s digital age [8].

Digital literacy can be seen as a learning process that finally yields to the development of 21st-century skill sets to address the job challenges of future workplaces [9]. Skills required for the 21^{st}-century includes problem-solving thinking, information gathering, critical analysis of the collected information, solution development, testing and validation, collaboration and communicating. Therefore, digital literacy is a whole process from collecting information to the creation of solutions for existing problems [10].

2.3. Digital Literacy Process

We see digital literacy as a learning process that enhances skills and competencies along the way of learning. As explained earlier, a digital literacy process has two paths, one can take both paths to achieve a high-level competency in digital literacy or can focus on the first path only. Our proposed digital learning process is shown in Figure 2 and explained below.

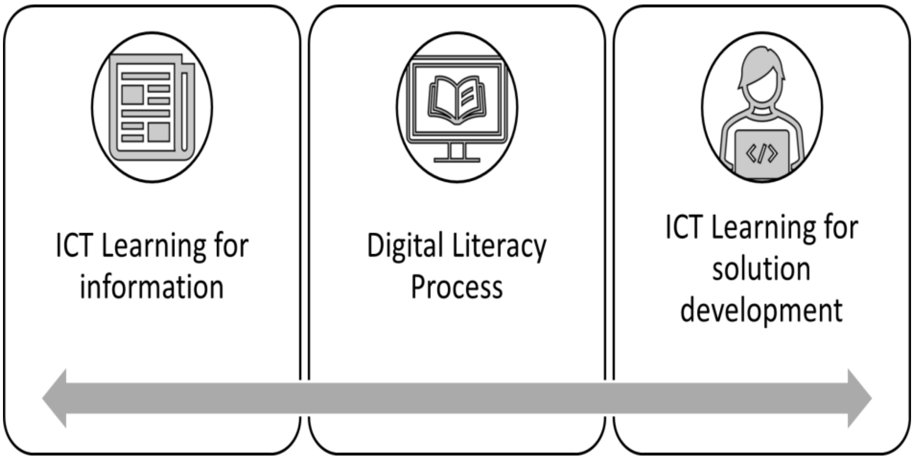

Figure 2. Digital Literacy Process.

ICT learning for information and communication: The First path of the digital literacy process leads to ICT learning for information. A learner can take this path to develop skills related to information seeking for understanding a problem, learner can identify fake and real information, can compare different sources of information, can critically analyze, and evaluate information, can deduce useful results/predictions from the collected information, can save and secure information, and can share and communicate information effectively and efficiently. Additionally, an individual will be capable of utilizing digital tools and applications in a friendly manner. Such a digitally literate individual will be capable of human-to-machine interaction and communication. During this process of learning a learner develops competencies including inquiry, analytical and critical thinking, collaboration, active interaction, communication, and ethical responsibility.

ICT learning for solution development: The second path of the digital literacy process is a more advanced path which leads to the idea creation and development for solving a problem. A learner can take this path to develop the skills required for idea creation and development to solve a certain problem. Adhering to this path enables learners to be capable of idea creation, collection of useful information, teaming up, collaborating, critical analysis of information and assumptions, developing models, applications, tools, testing and validating solutions, redesigning, and retesting if needed, communicating the results, interacting efficiently with machines and humans. Therefore, developing a certain solution for a problem and showcasing the required competencies and skills learned during the whole process. During this process of learning a learner develops competencies including brainstorming, idea creation, inquiry and research, analytical and critical thinking, collaboration, active interaction, design and development, computational thinking testing and validation, communication, and ethical responsibility. Table 2 below shows a set of competencies developed during the digital literacy process.

Table 2. Competencies acquired during the digital literacy process

Competencies	ICT Learning for Information and Communication	ICT Learning for Solution Development
Research and Inquiry	✓	✓
Analytical Thinking	-	✓
Critical Thinking	✓	✓
Problem Solving Skill	✓	✓
Computational Thinking	✓	✓
Collaboration	✓	✓
Design Thinking	-	✓
Evaluation	✓	✓
Active Interaction both Human and Machine	✓	✓
Testing and Validation	-	✓
Redesigning and Troubleshooting	-	✓
Security and Privacy	✓	✓
Ethical Responsibility	✓	✓

3. COMPUTATIONAL THINKING (CT) DEFINITIONS

CT has no straightforward definition so far. Researchers of the field have defined CT in many ways to understanding and elaborate on its purpose. Voogt in his research work, explains that rather giving a precise definition of CT, we should find similarities and relationships in the explanations explained by different researchers about CT [11].

Wing [12] in 2006 defined CT as an approach of designing systems, solving problems, and understanding human behaviour by drawing to the concepts fundamental to computer science.

Furber [13] conceptualized CT as a process of recognizing aspects of computation in the world that surrounds us and applying tools and techniques from Computer Science to understand and reason about both natural and artificial systems and processes.

Yadav in his research article termed CT as a process of the abstraction of problems and finding solutions for those problems [14]. Computational thinking (CT) is therefore broadly defined as the mental activity for abstracting problems and formulating solutions that can be automated.

Papert was the first to introduce the term computational thinking in a discussion, where he was explaining the impacts of computers on the people`s thinking and learning. He suggested that new types of mental process may develop due to the interactions with technology [15]. Therefore, computational thinking is considered a cognitive process—not an application of knowledge or a technique [16] [17] [18]. In another research work, CT is defined as a process of utilizing computers to model ideas and develop programs, clearly connecting CT to programming skills in [19].

4. Coding And Computational Thinking For Early Education

Computational thinking in the computer science field has a core place and CT is not just programming and coding. CT conceptualizes and brings all the science working behind different computer science tools and software. CT is a main constituent of digital learning process. We can develop CT skills in pupils by teaching them coding which is a form of writing to create solutions to certain problems. According to Wing, thinking as a computer scientist means more than being able to program a computer.

Coding/programming skills that is the ability to write a set of commands for a computer to solve a certain problem and computational thinking development have become a key need for early education. According to Gretter and Yadav [20] two approaches to 21st-century skills merge CT with UNESCO's concept of Media and Information Literacy (MIL) in support of students' 21st-century skills and citizenship. They argue that CT and MIL develop complementary skills of the learners to become active as well as reflective participants in their digital environment. They further argued that "the complementary relationship between computational thinking and media and information literacy provides educators with a comprehensive set of skills to allow students to both critically navigate and creatively produce digital content" (p.6). Therefore, writing programs is a means of developing new ways of thinking and creating digital content.

Computational thinking developing through coding skills enhances pupils' skill of understanding a problem and then breaking problems into parts and finally creating a solution for that problem. Coding skills develop intelligent thinking while a coder tries to write a more efficient and simple code rather than lengthy and complex coding to solve the problem efficiently and create an efficient solution to a certain problem. However, computational thinking makes things understandable and helps in unveiling the things behind the curtain during problem-solving journey. For instance, Barr [21] concluded that in K-12 education, CT involves problem-solving skills and particular dispositions, such as confidence and persistence, when confronting problems.

A Policy report titled "Developing Computational Thinking in Compulsory Education" published by the European Union in 2016 presented detailed policy directions and adaptations for developing computational thinking in compulsory education. This report also presented opinions on different EU countries about CT. Norway as a member state takes CT as an important element of learning to focus on problem-solving skill development to solve problems and create innovative solutions. Czech Republic embraced CT as a competence, and according to them , digital literacy is a precondition for thinking in a "computational" way. According to Hungary, an aptitude for computer usage can be fostered by observing and understanding the algorithms and functions of computers. Italy sees CT as a key to digital and media literacy. Lithuania explains CT as a mean to develop cognitive and digital skills. According to Poland, their new CS curriculum provides general digital literacy to all students. In the Maltese primary curriculum, CT is incorporated in the subjects of Digital Literacy and ICT. Wales has included CT in their Digital Competence Framework (DCF) which was adopted in September 2016 [22].

5. ICT LITERACY INITIATIVES AT K-12 LEVEL

Since the world is engulfed by the height of digitalization and technological progress, the education sector and governments around the world are more focused on developing digital citizenship than ever before. Countries around the globe initiating effective programs to amplify the efforts for digital skill development which is the burgeoning need of our times. It is noted that the European reference framework for the digital competence of citizens, DigComp in [22], includes programming as a core digital competence to develop at school levels. The recent update, DigComp 2.0 encompasses the main components of Information Literacy and parts of UNESCO's Media and Information Literacy.

In this section, we shed light on some of the initiatives taken in different parts of the world in recent years to develop digital competencies at the K-12 level.

In August 2019, a report has been published by the United Nations International Children`s Emergency Fund on digital literacy for children. The report presented a detailed discussion of different frameworks of digital literacy for children. The Report stresses on the fact that UNICEF must support the government and partners in adopting digital literacy within educational systems [23].

The Australian Council for Educational Research published a paper in 2016 to address the need of Digital and ICT literacy development for the progress of the society as a knowledge based information society [24].

European countries initiated many programs in the field of education to uplift digital learning and digital skill development. Some examples of such programs are the CoderDojo Foundation code activities; Digital Schools Award initiated by Ireland, Digital Schools Award; Ofcom; Future Learn and Childnet Digital Leaders Programs and Jisc by United Kingdom, MediaSmart Contest; Scratch Challenge; Initiation to Code at Primary School; Clubs of Code and Robotics by Portuguese, Connected Generations and Computer scientists without borders by Italy, and 5YeP4europe – Youth e-perspectives on migration. Finland included multiliteracies and ICT in its national core curriculum as an important skill to teach pupils and foster transversal competencies [25][26]. Above mentioned initiatives by different countries are just a few examples for understanding how different countries are developing digital competencies at the early education level.

Ministry of Education (MoE) of Korea have declared software education to be compulsory subject at K-12 level by 2018. Korean Ministry of Education has already initiated pilot programs at 72 schools nationwide in 2015 [27]. Similarly different Asian countries like Singapore, China, and Japan steered their nations through different digital literacy programs to acquire digital competencies and computer literacy to enhance skills like computational thinking and problem-solving for better societal impact.

6. AI FOR KIDS: A CASE STUDY

In this section, we present a case study for Artificial learning for children from ages 9-15. The author participated in an online AI course for kids as an observer. The main objective of this study was to find answers to the following questions: What is the age group of the course participants? Why are they interested in learning coding? What are the occupations of their parents? What do they know about AI/CODING? What kind of profession they want to have in future? What do they think about the course? (Language, convenience, usefulness, easy to understand) To find answers to these questions we prepared a Google form of 13 questions. Some questions are multiple choice questions, some are number scale questions and few of them needs answers in the form of small text. The total number of participants was n=9. As it was an online course, participants were participating from different countries like Pakistan, America, UAE, Finland, and Saudi Arabia. The aim of this study is to showcase that the computational thinking and digital literacy of young learners can be enhanced by teaching them coding and developing interest of new technologies like AI. We don't aim here to compare any methods or provide any kind of comparative study.

6.1. Course Information

The coding course was online taught by using Zoom. The course was taught by two teachers in the English language. The course content was divided into theory and practical parts. There were ten hours of learning, one hour per day. The main tool applied to teach coding and AI concepts to young learners was mBlock (mBlock - One-Stop Coding Platform for Teaching and Learning) [28], as block coding is an easy way to start coding at the beginner's level. Kids learned about the basics of coding, the logic of coding, they learnt to create games in mblock using loops and conditional logic and learned to use computer vision in game making. At the end of the course, kids presented their final projects. Kids were awarded with the certificates at the completion of the course.

6.2. Course Observations

The teachers of the course were friendly and helpful. They explained the coding process and related topics in a very detailed and simple way. The kids were given small projects to build. For that purpose, first, they learn and practice in online sessions and then they create their own small projects and present them in the next class. We found that kids faced problems but then they learned to solve the problems as well. Therefore, there was a sense of achievement and happiness among students. It is noted that such courses play an important role in building interest in young learners for coding. Each kid was having their own computer or tablet with good internet connection availability. It was also observed during the sessions that students were having a great support from their parents as well. As, if sometimes some kid was facing any connection problem, the parents were there to help. This shows the interest of parents in building digital competencies in their kids.

6.3. Questionnaire Results

We collected data from the students of the course in the form of a google questionnaire. The method used to collect data is error free in terms of any biases. The participants own point of views and answers related to the asked questions in the questionnaire are collected and then analysed and discussed. There were total of 9 responses that is the total number of participants were 9 (n=9). There were 13 questions. Questions and their results are discussed below.

Question 1: In which grade are you studying?

There were three students from 3rd grade, one from 4th grade, one student each from 5th, 6th, 7th and 8th grade and one student did not specify the grade, but grade range was 5-8. We can say that the student age ranges from 9-15 years. Responses for Q1 are shown below in figure 3.

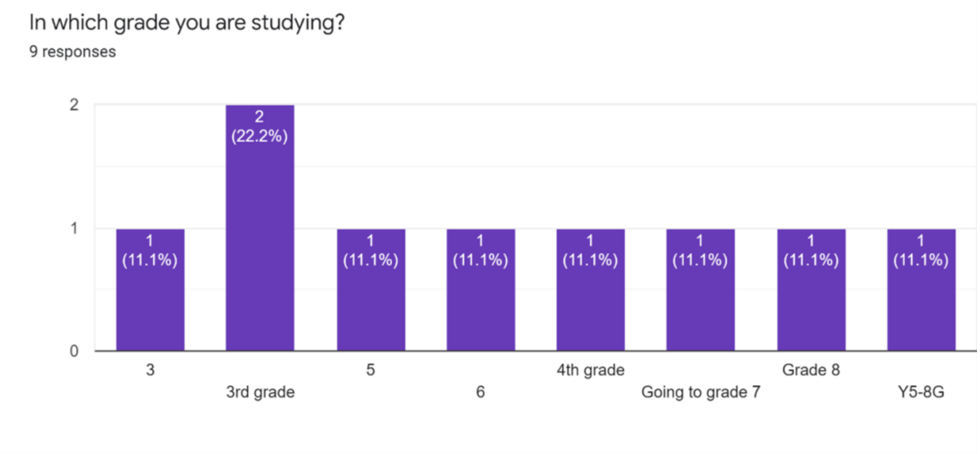

Figure 3. Grade level

Question 2: How old are you?

Responses shows that there were four students of 9 years old, two students of 10 years old, one of 11 years old and two students of 12 years old. So, the age of students ranges from 9-12 years. Responses for Q2 are shown below in figure 4.

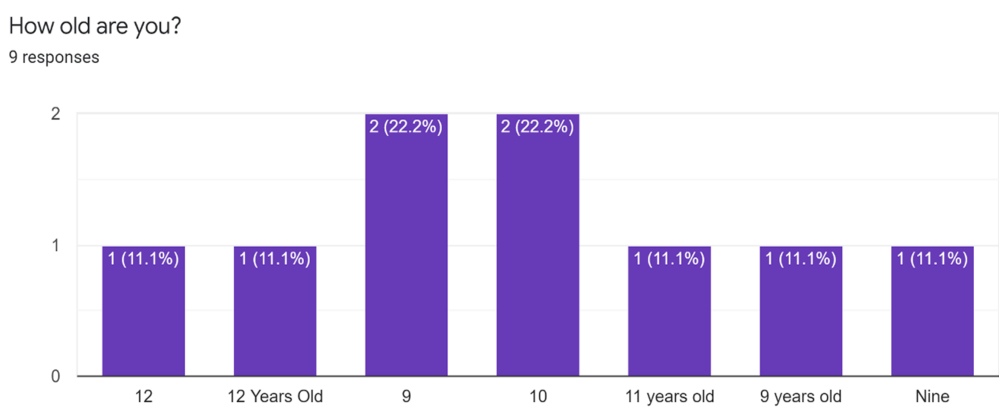

Figure 4. Age of the participants

Figure 5. Coding experience

Question 3: Do you have any coding experience, or have you studied coding earlier?
There were 8 responses out of 9 participants. 75 percent of the responders say that they have earlier experience of coding, while 25 percent were learning coding first time in this course shown in figure 5.

Question 4: What is Artificial Intelligence (AI)?

We gave options to choose if its AI. The options were if self-driving cars, chat bots, robots, computer, google assistants are AI or not. Most of the kids understood well and opted for right options. Responses for the Q4 are shown in figure 6.

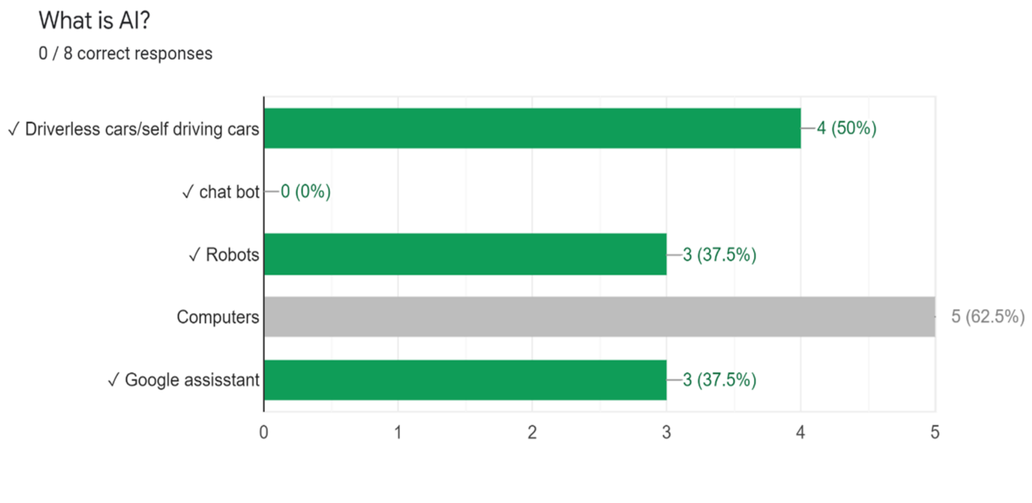

Figure 6. Knowledge about AI

Question 5: Coding is fun to learn.

We gave a number scale from 1-5. The answer can be selected in the form of numbers 1-5.1 is the minimum value and 5 is the maximum value. There were eight responses. Out of which 2 respondents selected number 3 and 6 respondents selected number 5 from 1-5 scale. Therefore, 75 percent thinks that coding is fun with maximum number value. Responses to the Q5 is shown in figure7.

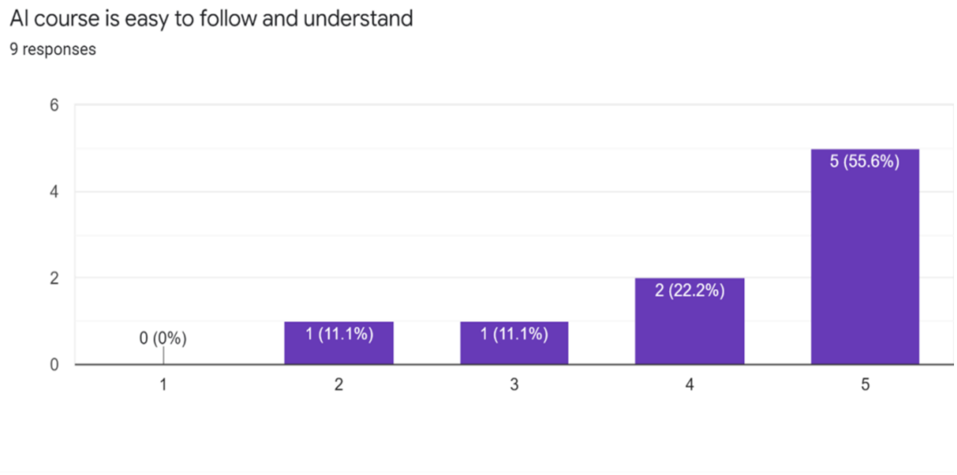

Figure 7. AI course is fun

Question 6: My parent`s profession is:

The respondents specify their parent`s profession in short text form. It is evident from the answers that participants of the course belonged to educated backgrounds. The professions specified by respondents were teaching, engineering, research, scientific job, army, consultancy, and office job. It is interesting to know that parents from different professions and fields are interested in developing digital and computational skills of their kids.

Question 7: I have free access to (what kind of devices?):

We want to know here that what kind of devices and facilities kids have, to learn online coding course. We have given them options like computers, internet, tablets, mobile phones, all the mentioned facilities, none, and if the kid needs permission to use these devices. Results shows that 66 percent of the respondents have computers and mobile phones, 55.6 percent of them have tablets, 55.6 percent of respondents have an easy access to internet, 11.1 percent of them has every facility mentioned, and 11.1 percent has mentioned that his parent`s permission is needed to use all facilities. We can see that overall, the participants of the course were having easy access to internet and internet devices to participate easily in the course. Responses for the Q7 are shown in the figure 8.

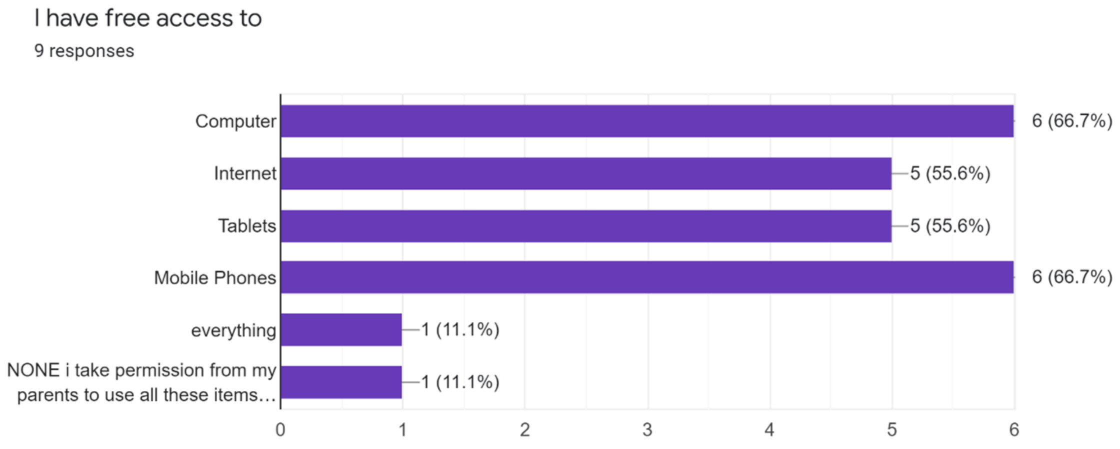

Figure 8. Available devices

Question 8: In the future I want to become (profession):

Respondents were asked to write answer in the form of a small text. We are providing here the answers of the eight responses we get from the participants. One of the participants did not give answer. The responses were as follows.

-I want to become an architect

-Soldier

-AI specialist and soldier

-Businessman of Ecommerce

-Artist or maybe an archaeologist

-Science teacher

-Software Engineer -Gymnast -Auto mobile engineer

We can observe that kids mentioned here a variety of occupations and it is evident from the choices of the professions that kids know well that what they would be requiring in future to pursue their careers.

Question 9: I am learning AI because I will use this knowledge in my future.
Responses were asked in the form of options (strongly disagree, disagree, neutral, agree, strongly agree).

We got 9 responses, out of which 55.6 percent strongly agree to the statement and 11.1 percent strongly disagree, 22.2 percent agree, and 11.1 percent remain neutral. Responses to Q9 are shown in figure 9.

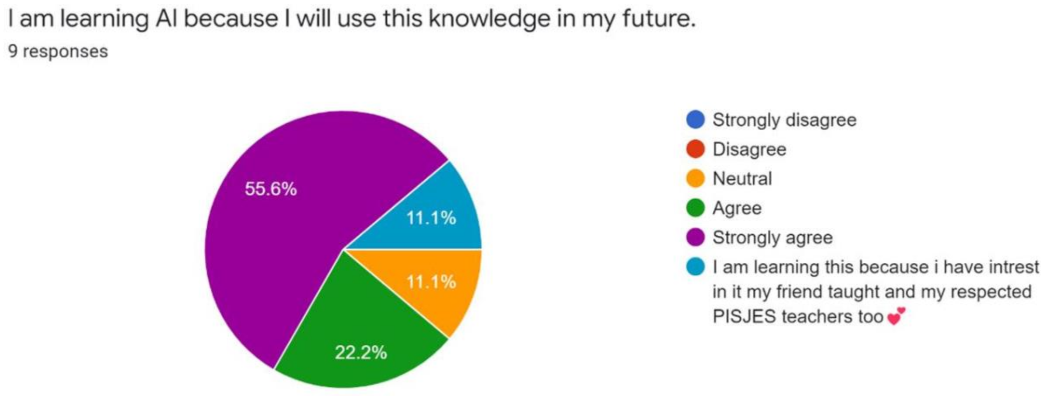

Figure 9. Knowledge for future

Question 10: I want to learn coding and programming in future too

44.4 percent of the respondents agreed while 33.3 percent strongly agreed that they want to learn coding and programming in future. While 22.2 percent remain neutral and did not clear yet about their future choice. This clearly shows that participants have developed interest in coding as shown in figure 10.

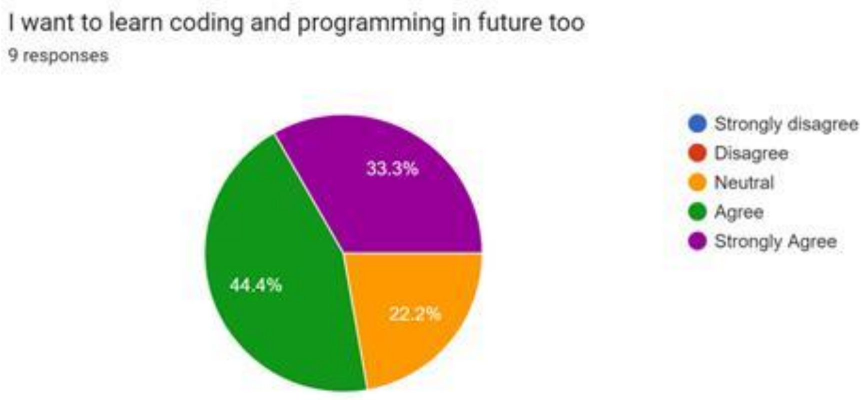

Figure 10. Learning coding in

Question 11: The most interesting thing to do in the course was:

We get different answers for this question as participants of the course did many different coding activities and they mention here what they liked the most. The responses are shown in the figure 11. They mentioned that they liked to do the coding, the mask tests, the ping pongame, the video sensing extensions, the pop the balloon.

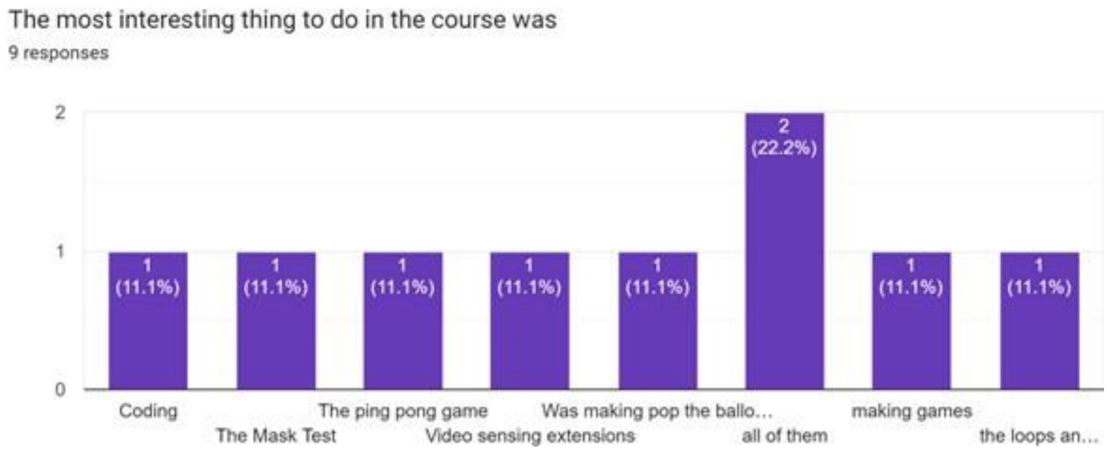

Figure 11. The most interesting part of the course

Question 12: I participated in the AI summer course by using the divice:

Results in the figure 12 shows that 77.8 percent of the course participants used their own computer/laptop, and the remaining used their iPad or tablets.

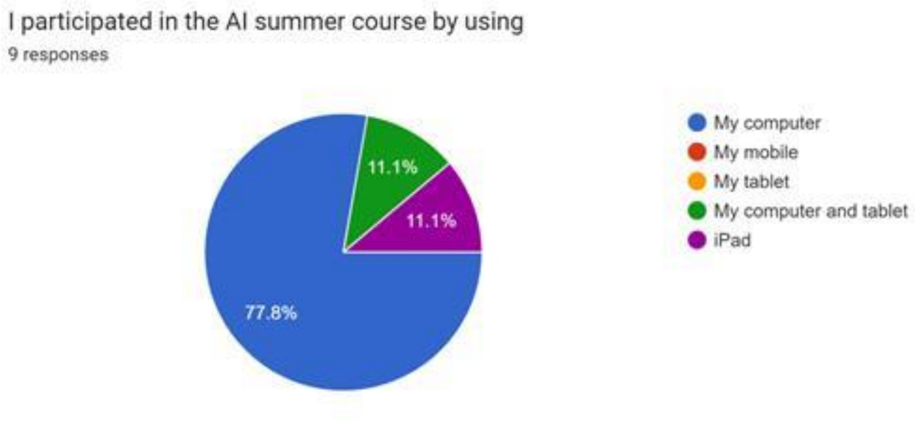

Figure 12. Devices used in the course

Question 13: What kinds of skills do you think you have developed during this course?
Response to this question was interesting and of great importance for us. As we argue that 21st century skill development is a challenge for today's education system. We should integrate skill development within the subjects taught. Programming and coding lessons are a good way to inculcate 21st century skills in future work force. As we have seen that participant of the coding course mention here that they developed different skills such as idea creation, creative thinking skills, designing skills, coding skills, digital/ICT skills, communication skills. Results are shown in figure 13.

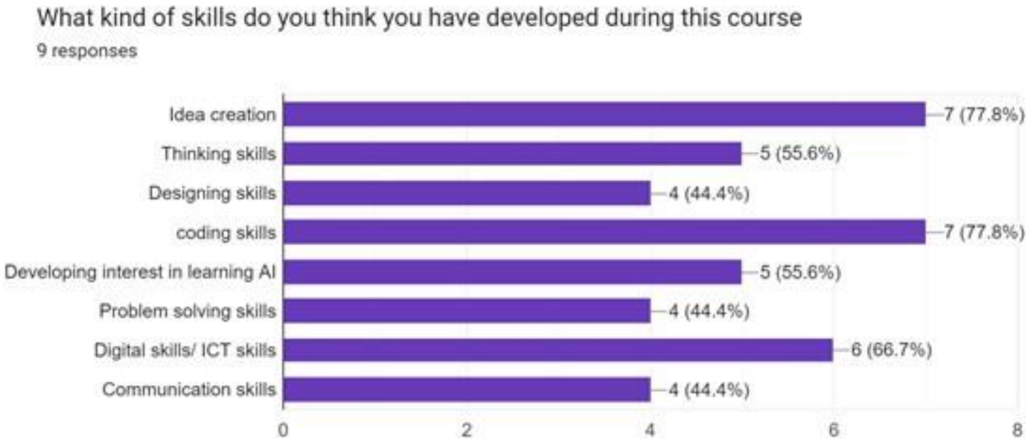

Figure 13. Skills developed during the course

1. RECOMMENDATIONS

In this section, we make some recommendations about how we can develop ICT skills by taking some initiatives at the K-12 level. As we discussed earlier today`s educational system needs holistic approaches to adapt ICT literacy and skill development. We need to integrate ICT education in regular school studies as a regular subject for all pupils to develop CT skills and ICT proficiency.

Integrated ICT curriculum: There is a dire need to develop and integrate ICT curriculum in regular school studies. It would be even more beneficial if we take ICT and CT skill development as a subject in the regular school study curriculum. The use of technology in the form of laptops, media projectors, touchscreen writing boards, tablets, and mobile phones is already common in normal school classes. But our focus should not be to teach how to use technology but to teach how to develop and create technology, how to solve problems and how to develop solutions. Therefore, the next step in K-12 school setup should be to teach kids to think critically and inculcate coding skills in pupils. We can integrate the ICT curriculum in many ways. For example, in maths class, kids can learn to solve mathematical problems (addition, subtraction, division) by writing small programs. Kids of our age are more interested in online gaming. We can develop a game development course for small school classes where students can develop their own games. For theoretical awareness of ICT, schools can arrange classes for kids to know how a computer works? How a robot talk? How can we do artwork on a computer? ICT curriculum development and integration not only help develop a future skilled workforce but also help parents. As parents pay for expensive coding classes. Most parents cannot afford and therefore, many kids are deprived of ICT learning skills just because they cannot afford it. Therefore, schools must offer and integrate ICT and CT skill development in their regular school studies.

Availability of required tools and devices: Schools must make sure to provide computers and internet to the students. In Europe and other developed parts of the world students in schools have easy access to computers and the internet. However, developing countries are struggling to provide quality education to their students. These developing countries even cannot provide quality education to their pupils if they take computers and the internet out of their education system. Therefore, computers, internet, free learning applications, and software are important requirements for supporting ICT and CT skill development at schools.

Fun events: School and home plays an important role in building a child's educational path. It is also evident that learning in a playful manner is more effective (reference needed) than learning in conventional ways. To develop a child`s interest and awareness in ICT learning and coding schools can organize events like coding parks, code day, code fairs, family day, etc. Such events bring liveliness to learning and more awareness to the parents and kids. Local universities can play a role in that regard. University students of IT background can volunteer to help schools in setting up such events.

Teacher training: Teacher training is the most important constituent of ICT and CT skill development path in schools. Only well-trained teachers can deliver the task. Therefore, there should be training offered to elementary school teachers to teach coding and ICT skills at schools. Sometimes technology fear hinders the performance of teachers. So, teachers should be provided with help and assistance in schools to overcome such difficulties. Local universities can play their role very actively here. University students of IT background can help schoolteachers in teaching things like coding and assist teachers at school. In return, they can get credits from their universities to complete their degrees. Government, city administrations, councils, and universities, Schools, must arrange ICT training courses and develop pedagogy for supporting ICT and CT skill development at K-12 schools.

Assessment: In any learning activity assessment and feedback is an important part of that learning. Most of the strategies assess ICT and CT skills by analyzing the artifacts (e.g., games, models, designs) that students develop as indications of their ICT capabilities. Students can also be assessed by giving them assignments to achieve different objectives by modifying their code or in other words making more complicated or sophisticated models or games. Assigning to simplify a program with efficient results is another way to assess the capability of the learner. Debugging and troubleshooting an existing program could also be an effective way to assess students' fluency in computer coding and problem-solving. The use of multiple-choice the assessments and attendant rubrics to assess the CT skills of middle school students is also mentioned in the literature. A study [20] explains and discussed about the assessment of student learning Computer Science (CS) in high school in the USA. Similarly, Simon Peyton Jones discusses in the expert interviews that the Computing at School initiative has started a project to assess primary and secondary schools called Quantum on assessing computing [29].

8. DISCUSSION

Our research work in this article has focused on an important issue of developing ICT and computational literacy in young school kids. This challenge will have a profound impact on our future workforce if this challenge would not be handled at this point. The Future industrial revolution and digitization demand a fully digitally literate work force which can not only handle the digitized environment in the pretext of machine-machine and machine-human interaction but can also solve problems and create innovative solutions as well. In our research paper, we showcased a case study of an online coding class. We collected data in terms of student's codes, designs, and games they made. We also observed the class communication, the manner the classes were conducted, and the way students participated. We also collected student`s responses about the course and their feedback. From the data presented above we have noticed many important things. We discuss the important takeaways here:

Availability of the courses: So far, we have observed a trend in many places that coding is taken as an extra hobby lesson organized by private organizations and institutes. It is observed that such coding courses are available online and on campus but there is always a cost related to the courses. Therefore, there is a need for free courses available to everyone. If schools take coding and computational skill development as a part of the curriculum in additional to mathematics, then it would be accessible and available for everyone.

Accessibility: A certain cost attached to a particular course hinders its accessi bility to many kids who simply cannot afford such courses. We argue for accessible skill development for everyone. It would be worth providing such skills to kids free of cost. It can be done by adding coding and computational skill development in the regular school curriculum.

Language and communication: As, in the coding course presented here, the language of instruction is English. Therefore, language of instruction and ease of communication play a vital role in the learning process. All the participants of the course and the teachers speak English language as a language of instruction and the level of communication was well established. Course teachers communicated with participants online, through Zoom, by email, and in groups by chatting. Interaction: A strong interactive environment is needed in coding classes. Interaction is a challenge when the class is online. We observed that during online sessions students require more motivation and interaction as compared to face-to-face teaching. Plenty of interactive tools such as jam board [30], kahoot [31], and mentimeter [32] are available for interactive learning.

Tasks and assessment: In any learning activity assessment and feedback is an important part of that learning. ICT and CT skills can be assessed by the artifacts (e.g., games, models, designs) that students develop, which portray student`s ICT capabilities. Students can also be assessed by giving them assignments to achieve different objectives by modifying their code or in other words making more complicated or sophisticated models or games. In the studied case, the instructor of the course gave tasks of developing small games to his pupils by using the m- block. Many interesting games were developed by the participants.

Family background of pupils: It is worth to discussing here that we observed during our study that parent`s background also affects kid`s choice of future profession and eagerness to seek more knowledge. Kids with educated backgrounds show more interest in learning and future career path development.

9. CONCLUSIONS

In this article, we emphasized on coding and computational skill development. We argued that computational skill development and digital literacy development is an important requirement for the future workforce. Along with computational skill development, coding skills are equally important. K-12 Schools should adopt coding in their regular curriculum so that it can be available to all students. Future work requirements demand a skilled workforce with digital literacy to solve problems and create innovative solutions. We discussed the initiatives taken by different countries around the world to enhance computational thinking and digital literacy among young learners. In this research, we showcased that how an online coding course developed coding and computational thinking skills in the kids aged 9-17. Therefore, this is high time to create such kind of curriculum which focuses on the development of digital literacy skills including coding and computational thinking. We encourage and recommend educators and managers of education to take holistic initiatives to promote ICT skill development at k-12 level to prepare skilled future workforce.

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