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Review article

Potentializing Green-IoT, AI and 6G Technologies in Computational Thinking

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Computational thinking is a problem-solving approach that involves breaking down complex problems into smaller, more manageable parts and identifying patterns and relationships between different components whereas Green-IoT and Artificial Intelligence (AI) in 6G environment are important approaches for potentializing an effective Computational Thinking solution. AI approaches involve developing algorithms that can learn from data, make predictions and decisions, and perform complex tasks without explicit programming. When it comes to Green-IoT, both computational thinking and Artificial Intelligence can be used to analyze and interpret the massive amounts of data generated by connected devices using 6G communication networks. This can lead to more intelligent and efficient use of resources, as well as improved automation of various processes. The combination of Green-IoT, AI and 6G Technologies in computational thinking has the potential to transform various industries including the educational one and improve the quality of life for individuals is expected to lead to new applications and services that are more intelligent, efficient, and personalized. This research presents a review on computational thinking, particularly, we first give an overview of essential parameters through Green-IoT enabled sensor technologies under 5G, 6G environment and Artificial Intelligence. We then present an overview of requirements of basic architecture for IoT and AI based computational thinking system considering key attributes to potentialize social applications and discussing their strengths and weaknesses in the context of framework for community services. Finally, we present various security threats to an AI-based architecture to design robust and resilient computational thinking services system needed in the context of social networking.

1. INTRODUCTION

The study on computational thinking has steadily gained the interest of academicians and educators both locally and globally because it is the fundamental quality that modern multidisciplinary talents should exhibit. The process of computational thinking entails converting everyday difficulties into computer-solvable issues and then employing computer-based solutions to the current issue. All tasks, including those that even don't use computers, can be built on this method of thinking.[1-3] The amount and heterogeneity of educational data, which can be processed, combined, and used for better decision-making, have dramatically increased because of the expanding use of information and communication technologies (ICT) in the educational sector. To prevent the job from becoming infeasible for humans, it is crucial to have resources, computational tools, and algorithms that can spot patterns, trends, or regularities in the data.[4] For accomplishing this task, the use of Green-IoT, AI and 5G or 6G technologies is inevitable and requires sophisticated IT platforms. In technical and engineering disciplines, the concept of Outcome Based Education has received significant attention from all stakeholders but due to large volume of data aggregation and processing, the higher education institutes are facing acute difficulties in its implementation in true spirit. However, the dramatic advent and entry of information and communication technologies' engagement can reduce their miseries by booting up fast data processing, rapid communication channels, Machine Learning tools and data analytic algorithms under Green-IoT environment. The Unsupervised Learning Strategies K-Means, Educational Data Mining, Knowledge Discovery in Databases methodology, Orange Data Mining Canvas, JClic and Learning Analysis Rubrics, are found as the popular AI approaches in literature for an immersive and personalized education and learning system.[3] However, it is important to consider the ethical implications of using these technologies and to ensure that they are used in a responsible and transparent manner.

The purpose of this work, taking into account the technological framework mentioned above, is to present a review of key computational thinking dimensions combined with Learning Analytics and Educational Data Mining techniques with unsupervised machine learning strategies,

Green-IoT enabled sensor technologies under 5G and 6G communication systems, and Artificial Intelligence based tools such as Machine Learning to identify learning difficulties of the learners.[3,5] The remainder of the part focuses on presenting an architecture for an IoT and AI-based computational thinking system, outlining the essential conditions for social applications, and analyzing their advantages and disadvantages in relation to a framework for social services. Then, using a thorough methodology, we investigated the inherent security risks for AI-based architecture and their remedies in order to build reliable and resilient computational thinking services systems required in the context of social networking and related issues.

2. ANALYSIS

The majority of people regard computational thinking abilities to be lifelong learning and problem-solving abilities. Programming content tools like Scratch, Python, C++, robotics, software packets, blocked based programing tools and CS-unplugged activities are used to investigate how Computational Thinking skills develop. In addition, university instruction makes use of arithmetic, games ,[3] graphic design for older adults, etc., as shown in Figure 1. Robot programming is an independent variable, though, and research has shown that computational thinking abilities go beyond programming schooling to include abilities like problem-solving, performance evaluations, and activity scales.

The academic community should implement efficient exercises or resources to encourage computational thinking among students, particularly when formative evaluation is used. Designing instructional sets for computational thinking must place a focus on tools other than programming languages.

3. GREEN-IOT AND 6G INVOLVEMENT IN COMPUTATIONAL THINKING

Two new technologies that have the potential to significantly play vital role in computational thinking are green IoT and 6G. The term "Green-IoT" describes the application of Internet of Things (IoT) technologies and devices in a manner that conserves energy and encourages sustainability. By using IoT devices that are intended to be energy-efficient and by optimizing the use of resources, Green-IoT can help to reduce the carbon footprint of businesses and individuals thus can be an effective technology for design and development of Computational Thinking system.[5] The sixth generation of wireless technology is referred to as 6G, on the other hand. Compared to current 5G technology, it is anticipated to offer much faster data speeds and reduced latency, which could open a variety of new applications and services including Computational Thinking like use of robotics and automation. Computational thinking, which is the process of disassembling complex problems, can be used in both Green-IoT and 6G. Similarly, computational thinking can be applied to 6G[5] to create new protocols and algorithms that can benefit from the reduced latency and higher data rates to offer new services. In general, Green-IoT and 6G are both fascinating fields of study and development that could have a big effect on computational thinking. We will probably see a lot of new applications and services emerge that are based on the principles of computational thinking as these technologies continue to develop and mature.

4. ARCHITECTURE FOR IOT AND AI BASED COMPUTATIONAL THINKING SYSTEM IN SOCIAL APPLICATIONS

To design an architecture for an IoT and AI based computational thinking system for social applications, we need to consider the following key requirements:

Scalability: The system should be designed to scale easily and accommodate large volumes of data from various IoT devices and sensors.

Reliability: The system should be reliable and able to handle failures gracefully, without compromising the quality of service.

Security: The system should be designed with strong security features, such as encryption and access control, to protect sensitive data and prevent unauthorized access.

Interoperability: The system should be able to integrate with other systems and platforms, allowing for seamless data exchange and collaboration.

Real-time processing: The system should be able to process data in real-time, enabling quick decision-making and response to events.

Machine learning and AI: The system should be capable of using machine learning and AI algorithms to analyze data, detect patterns, and make predictions.

Based on these requirements, a potential architecture for an IoT and AI based computational thinking system is designed[5] whose social applications could include the following components:

IoT devices and sensors: These devices and sensors would collect data and transmit it to the system.

Data processing and storage: The collected data would be processed and stored in a distributed database or data lake, using technologies such as Apache Kafka, Apache Cassandra, or Apache Hadoop.

Machine learning and AI algorithms: The system would use machine learning and AI algorithms to analyze the data and make predictions, using frameworks such as TensorFlow, PyTorch, or Apache Spark.

Application layer: The application layer would provide APIs and interfaces for developers to build social applications on top of the system, using programming languages such as Python or Java.

User interface: The user interface would provide a way for end-users to interact with the system and the social applications, using web or mobile interfaces.

Overall, such an architecture would enable the development of scalable, reliable, and secure IoT and AI based Computational Thinking systems that could be used to solve complex social problems and improve people's lives.

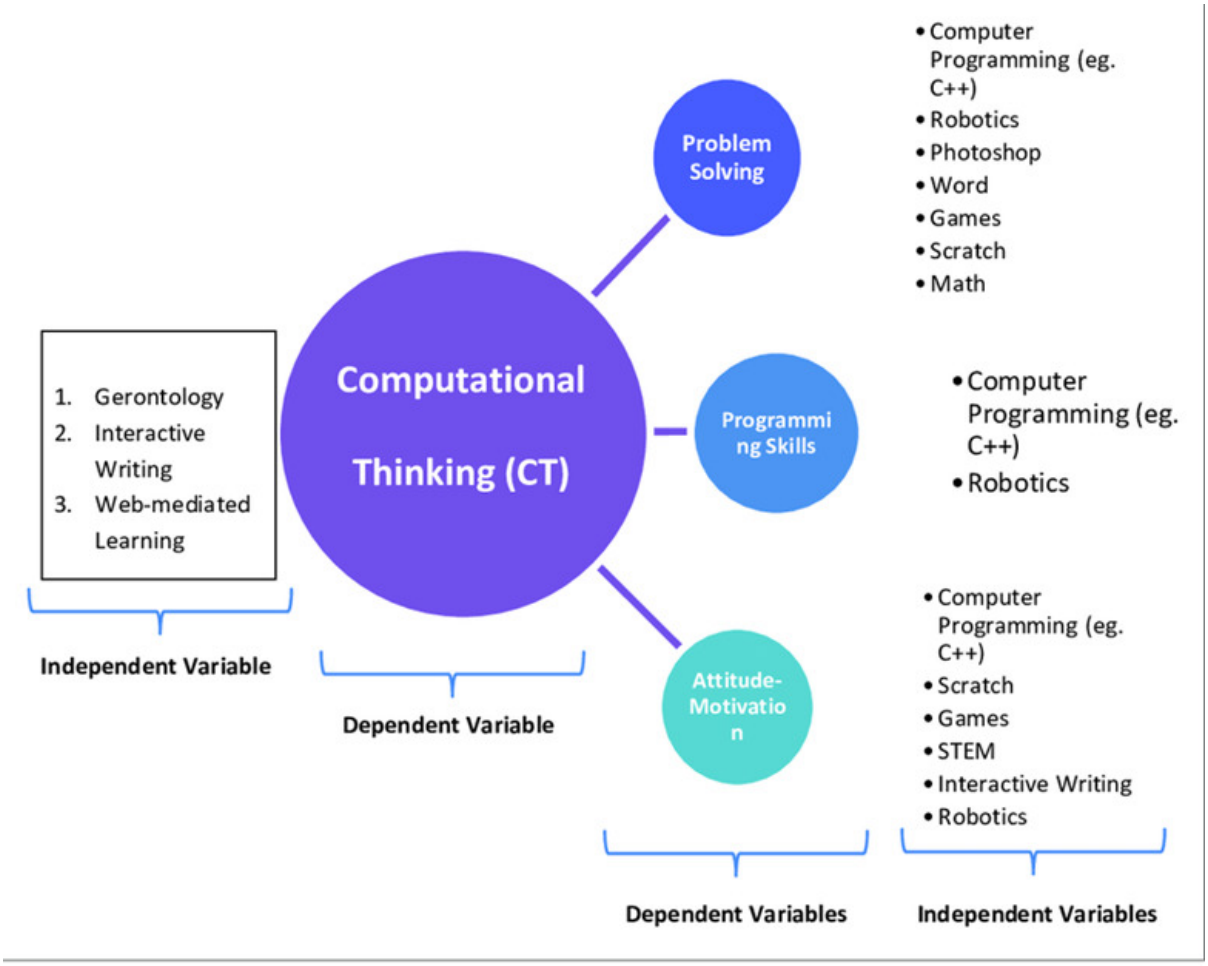

Fig. 1. Relationship between dependent and independent variables in the studies[6]

4.1. STRENGTHS AND WEAKNESSES OF COMPUTATIONAL THINKING SYSTEM ARCHITECTURE

Computational thinking architecture has several strengths and weaknesses that can impact its effectiveness in solving complex problems. Here are some of the key strengths and weaknesses:

STRENGTHS

Flexibility: Computational thinking architecture should be highly flexible and can be adapted to a wide range of problems and domains.

Modularity: Computational thinking architecture is modular, which means that it can be broken down into smaller components that can be easily modified or replaced without affecting the entire system.

Scalability: Computational thinking architecture is designed to be scalable, allowing it to handle large volumes of data and processing tasks.

Interoperability: Computational thinking architecture is designed to be interoperable, which means that it can work with other systems and platforms.

Automation: Computational thinking architecture can automate repetitive tasks and processes, reducing the need for manual intervention and improving efficiency for learners.

WEAKNESSES

Complexity: Computational thinking architecture can be complex, which can make it difficult to design and implement.

Cost: Implementing computational thinking architecture can be expensive, especially when it involves the use of advanced technologies such as machine learning and AI.

Skill requirements: Implementing computational thinking architecture requires specialized skills and expertise, which may be difficult to find or expensive to acquire.

Security: Computational thinking architecture may be vulnerable to security breaches and attacks, especially when it involves the processing of sensitive data.

Ethical concerns: Computational thinking architecture may raise ethical concerns related to privacy, bias, and fairness, especially when it involves the use of machine learning and AI algorithms.

The strengths and weaknesses of computational thinking architecture depend on the specific context and problem being addressed. By carefully evaluating these strengths and weaknesses, organizations and individuals

can evolve a robust computational thinking architecture for learners.

5. SECURITY THREATS IN AI-BASED COMPUTATIONAL THINKING SYSTEM

Artificial Intelligence (AI) is becoming increasingly ubiquitous in today's technology landscape, including social networking for Computation Thinking. While AI systems offer tremendous potential to enhance the functionality and user experience of social networking, they are also susceptible to security threats that could compromise user privacy, data integrity, and system availability. Some of the most significant security threats to AI-based Computational Thinking architecture in social networking, along with its potential solutions are mentioned below:

Adversarial attacks: Adversarial attacks are a type of security threat where an attacker deliberately manipulates the input data to mislead the AI system's decision-making process. For instance, an attacker could insert a fake image or video into the social network to fool AI-based image recognition algorithms. To combat adversarial attacks, AI systems can be trained to detect and defend against such attacks by incorporating techniques such as anomaly detection and model hardening.

Data poisoning: Data poisoning refers to the practice of injecting malicious data into an AI system's training data set to compromise its performance. For example, an attacker could inject false information into a social network's user profiles, leading to biased decisions by AI algorithms. To prevent data poisoning, AI systems must implement data verification and validation protocols to ensure the integrity and authenticity of data sources.

Model stealing: Model stealing involves extracting a trained AI model from a target system, which can be used for malicious purposes such as intellectual property theft or reverse engineering. To prevent model stealing, AI systems can employ techniques such as model watermarking and obfuscation, which add a unique identifier to the model or obscure its structure to make it harder to steal.

Insider threats: Insider threats occur when individuals with authorized access to an AI system deliberately or accidentally misuse the system. For example, an employee with access to a social network's AI system could leak sensitive user data to unauthorized third parties. To mitigate insider threats, AI systems must implement access control mechanisms, continuous monitoring, and threat detection algorithms.

Some key steps to design a robust and resilient AI-based architecture in social networking and computational thinking system are mentioned below:

Threat modeling: Identify potential security threats and vulnerabilities in the AI system and its ecosystem and develop mitigation strategies for each.

Secure software development: Implement secure coding practices and conduct regular security assessments to identify and remediate vulnerabilities in the system.

Data management: Implement robust data governance and security protocols to ensure data integrity, privacy, and confidentiality.

Access control: Implement access control policies and mechanisms to limit access to sensitive data and system resources.

Continuous monitoring: Implement continuous monitoring and threat detection mechanisms to detect and respond to security incidents in real-time.

Incident response: Develop a comprehensive incident response plan that outlines procedures for responding to security incidents, including escalation procedures and communication protocols.

The key to designing a robust and resilient AI-based architecture for Computational Thinking System is to take a proactive approach to security, with a focus on threat modeling, secure software development, data management, access control, continuous monitoring, and incident response.

6. RESULTS AND DISCUSSIONS

Learning to think critically is more crucial than memorization for pupils. One of the advances in this school of thought is Computational Thinking. Using a variety of sensor-type devices, for instance, to identify and process different physical quantities such as sound, light, heat, force, etc. The outcome of processing may include record numbers for statistical data storage or the control of IoT devices.[7] The design and construction of a demonstration kit for different embedded system sensors is an effective technique in CT. Since computational thinking (CT) is regarded as one of the key 21st-century skills that will help develop global citizens in this age of disruptive technologies, there has been a resurgence of interest in both primary and higher education research in recent years. Artificial Intelligence (AI) and machine learning, two additional new digital technologies involving real big-data utilization, call for manipulation, usability, and adaptability skills. The growth of programming skills is supported by CT,[8,9] which also offers a sustaining tool to help with problem-solving goals. Since computational thinking (CT) is regarded as one of the key 21st-century skills that will help develop global citizens in this age of disruptive technologies, there has been a resurgence of interest in both primary and higher education research in recent years. In comparison, programming training and practice could enhance CT skills. However, improving students' computational thinking abilities in the setting of teaching programming remains challenging.[10] Programming depends on a student's specialized abilities in systematic and logical thinking because CT is the pathway in general problem-solving in real-world circumstances.[9] Some students might feel constrained by the necessity of writing a substantial amount of code in order to create effective programs for these intricate processes.

7. CONCLUSION

The study on computational thinking has steadily caught the global interest of academics and educators. Computational thinking is the fundamental quality that contemporary multidisciplinary talents should possess. The process of computational thinking entails converting everyday difficulties into computer-solvable issues and then employing computer-based solutions to the current issue. All educational tasks, even those that don't require computers, are built on this method of thinking. Engineering thinking is rational thinking, and from the perspective of technology, in the past, professors teaching computer technology courses frequently only had technical knowledge and lacked engineering thinking. As a result, students frequently only had textbook knowledge but encountered specific problems. You are unable to apply your technical expertise when faced with difficulties. When you encounter difficulties, you are unable to utilize your technical expertise to complete the programming of particular tasks more quickly and accurately. The IoT-enabled 6G technology will significantly improve computational reasoning. However, the use of Green-IoT equipment, 5G/6G systems, and AI-based tools should be taken into consideration when designing the learning environment in educational institutions.

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