Application of IoT in Analyzing Cognitive Skills of Students-A Systematic Literature Review

Rajeshwari M.[1, 2] & Krishna Prasad K.[3]

[1]Research Scholar, College of Computer Science and Information Science, Srinivas University, Mangalore, India

[2]Assistant Professor, Dept of Computer Science, St Philomena College, Puttur, India

[3]College of Computer Science and Information Science, Srinivas University, Mangalore, India

[1, 2]ORCID ID: 0000-0001-9613-4967, E-mail: rajimuraleedhar@gmail.com

[3]ORCID ID: 0000-0001-5282-9038, E-mail: krishnaprasadkcci@srinivasuniversity.edu.in

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[3]College of Computer Science and Information Science, Srinivas University, Mangalore, India

[1, 2]ORCID ID: 0000-0001-9613-4967, E-mail: rajimuraleedhar@gmail.com

[3]ORCID ID: 0000-0001-5282-9038, E-mail: krishnaprasadkcci@srinivasuniversity.edu.in

ABSTRACT

The Internet of Things is an interrelated system of computer equipment, digital and mechanical machinery with unique identifiers, capable of transferring and relocating data over the Internet in the absence of human-to-computer involvement or without human-to-human interactions. The entire future of the global technology will swing around the Internet of Things, which is bound to connect a large quantity of SOs- Smart Objects, or articles or entities to transform the physical environment around us to a digital world. The application of IoT involves several domains like smart grids, smart farms, better healthcare, smart cities, smart homes, smart transportation system, smart parking and so on. The problem-solving and conceptual knowledge obtained in school is basically inert for several students. In certain situations, knowledge acquired remains surface bound features of problems, as learned from school classes and textbook presentations. The Cognitive computing process uses the available data to react to changes in order to make the right decisions based on specific learning processes from past experiences. In the case of cognitive apprenticeship process, there is a need to bring deliberately the thinking process and thoughts emerge, to produce them to be visible, whether in the case of writing, reading, or problem solving. The thoughts of the teacher must be completely visible to all the students, while the thinking of students must be clearly visible and readable to the teacher. The mental capabilities of students are developed through the cognitive skills that the students need to learn to be successful in school. To effectively understand, write, read, analyze, remember, think, and solve all the problems, the students of these cognitive skills should gather so as to function collectively and properly. If these skills become weak, the students will start to struggle, unable to face problems and solve them correctly. The new learning method makes the students observe, perform and practice the subjects from both the teachers and their peers. In view of this, this study of literature review investigates and explains the concept of IoT by conducting a systematic review and assessment of corporate and communal white papers, scholarly research articles, journals and papers, professional dialogues and discussions with researchers, academicians, scholars, educational experts along with online database available. Purpose and goal of this paper is to analytically categorize, and examine the prevailing research techniques and applications of IoT approaches on cognitive skills of students towards personalization in education. The limitation of the study is that it deals only with the subject matter's application components which leave physical components.

Keywords: Cognitive Skills, Smart Objects, Personalized Education, IoT Applications, Cognitive Apprenticeship, Smart IoT.

1. INTRODUCTION :

The internet of things (IoT) will be a very complex network with much broader scope than the current internet and much more complexity. So, connectivity is what will be observed in this new era of ubiquity, i.e., anywhere, anytime, & any amount of time. The IoT is an interrelated system of computer equipment, digital and mechanical machinery with unique UID identifiers and capable of transferring and relocating data via the Internet network in the absence of human-to-computer involvement or without human-to-human interactions (Shammar, & Zahary, 2019) [1]. The Internet of Things functions as a perfect ecosystem for confining smart and intelligent objects prepared with networking, sensors, integrating processing technologies, collectively delivering smart services to end users in such an environment (Lianos, & Douglas, 2000) [2]. As emphasized by Kosmatos, Tselikas, & Boucouvalas, (2011) [3], The concept of IoT is primarily guided by abundant benefits in people's lives through a favorable environment in which all smart service applications are made available to use any interesting action at anytime and anywhere. The combination of Smart Objects and IoT enables many valuable, innovative and powerful applications to be formed, and can powerfully involve, shape and influence nearly every facet of the personal daily lives of users. IoT's application involves multiple domains such as smart grids, better healthcare, smart farms, cities, homes, transportation systems, parking etc. (Farhangi, 2010) [4]. For several students, the problem-solving and conceptual knowledge acquired in school is basically inert. In some situations, acquired knowledge remains surface-bound problem features, as learned from school classes and textbook presentations. The thinking process and thoughts must be deliberately brought forth, produced to be visible, whether in the case of writing, reading, or problem-solving. The teacher's thoughts have to be fully visible to all students, while student thinking has to be clearly visible and readable to the teacher. That is the biggest difference between traditional learning and cognitive apprenticeship. In the case of cognitive apprenticeship, the challenges must be faced if the school curriculum abstract tasks are to be placed in the correct context to make sense for the students involved (Moeinfar, *et al*., 2012) [5]. The purpose and goal is to help students simplify their learning skills and, if the skills are not applicable, to independently transfer those skills for the better cause when faced with new situations (Chen, & Jin, 2012) [6]. This literature review study is generated using the secondary data obtained by conducting a systematic review and evaluation of corporate and community white papers, scholarly research articles, journals, and papers, along with available online databases.

The paper is highlighted with these following subsections: (i) Need of cognitive skill analysis, (ii) Components of cognitive skill analysis, (iii) IoT in Nutshell, (iv) Application of IoT in cognitive transformation, (v) Framework of IoT based cognitive computing system, (vi) Cognitive apprenticeship approach in education, (vii) IoT for personalized learning, (viii) Use cases of IoT in cognitive skill analysis, (ix) Summary of related work, x) Discussion, (xi) Research Gap, xii)Research Agenda, and (xiii) Conclusion.

2. RESEARCH AIM AND METHOD :

The literature review is conducted to identify IoT applications and solutions for analyzing student cognitive ability. Therefore, SLR requires finding various solutions to the identified problems. It also expects some models and approaches to analyze the solutions based on certain constraints. Finally, the analysis ends with the strength of the evidence and its implications. We have research questions based on that objective:

- RQ1: What are IoT applications and how did they affect human daily life?
- RQ2: What are IoT solutions applicable in Smart Classroom to find the cognitive skill of a student?
- RQ3: How do the different solutions prove themselves as best?
- RQ4: What implications will these findings have?

3. OVERVIEW OF COGNITIVE SKILL ANALYSIS :

To improve knowledge of student both visually and verbally, they need to learn. A new classroom is provided with infrastructure such as remotely accessible hardware, software, wireless technology, and association tools to build a smart setting in real world of education. Classroom with Internet of things products, service and experiences are come into existence. Students use cloud-based technology to model the class with networks and simulation at home too. With other peer instructors worldwide, instructors or teachers are empowered with a customizable learning platform.

Above all, the basic requirement in classroom is concentration. If somebody is ineffectual and shows weakness in some area of study, it can influence many different areas of cognition. Sometimes in some topics, students may find difficulty and their practice shows that spending more time solves a problem will result in inadequate performance and results. The proper method of teaching will help improve concentration while doing practical work with the practice. Cognitive computing involves providing the required working capacity for computers to solve very complex problems by themselves. Similar to humans, the actions of cognitive computers gained great advantage from experience, by understanding and learning improved ways of solving any problem with each action and encounter. When conventional systems and rules meet complex tasks, cognitive computing observes and satisfies the opportunity to broaden their knowledge (Bisht & Pooja, 2019) [7].

Due to the modern business needs of more important data, there is a cognitive computing necessity in the IoT. At the venues of the future smart IoT, all of them, from startups to large companies and homeowners, will find the need to use relevant data while making the right decisions, and they can do so after knowing facts rather than using their instincts (Sanjiv, 2016) [8]. In the research area, new IoT applications and technologies are emerging every day to analyze and enhance a student's cognitive skills in education.

3.1. NEED OF COGNITIVE SKILL ANALYSIS

The process of acquiring knowledge involves the development of thought, sense, and experience by understanding and enhancing mental action or memory is called cognitive skill. It involves intellectual processes such as attention in studies and leads to knowledge formation in memory. The knowledge stored in working memory is used for proper judgment, assessment and reasoning, decision-making, problem-solving and computing. Cognitive processes will therefore use existing knowledge to generate new knowledge at various places of learning. The school tasks demand the students to learn only those things learnt in school and also transfer them exactly what they learnt. In the case of cognitive apprenticeship, however, the challenges are the same, but to demonstrate several aspects of the task that vary from a systematic way of working with a variety of performance systems, and then to motivate students to reflect what they have learned and understood to articulate all the elements and features familiar with the tasks. When the teachers offer their students the specific targeted skills, they should consistently increase and vary the perspectives in which the skills can be applied and are useful. New idea is built to help students simplify their learning skills and, if the skills are not applicable, to independently transfer those skills for the better cause when faced with new situations (Chen & Jin, 2012) [6]. Students' mental abilities are developed through the Cognitive abilities that students need to learn to be successful at school. To understand, write, read, analyze, remember, think and solve all of the problems effectively, the students of these cognitive abilities should gather to function collectively and properly. If these skills become weak, the students will begin to struggle, will be unable to face and solve problems properly. There are several most important cognitive skills which are important for all students to study (Janelle Cox, 2009) [9]. Concentration is the basic thing that works on cognitive skill teaching and that is how it is taught. The method of teaching cognitive skills will help improve concentration while doing practical work with the practice. If someone is ineffectual and shows weakness in this area, it can affect many different areas of cognition. The development of cognitive skills will teach learner the way to develop selective attention and concentration, learn how to ignore and avoid distractions, and stay firm on the specified work. Students will also learn to create divided attention, to execute multitasking. When students learn to do this work, they will develop higher cognitive functioning skills, which will help them to succeed in school. (Bajwa & Gula, 2019) [10]. After a decade of learning and developing their cognitive skills, students explained that, "I am now aware of the process of cognitive skill development and feel safer and more in control of any situation after going through my cognitive procedures that previously frustrated me. I know and understand its value clearly, which redirects my natural drive and impulses, ranging from problem-solving behaviour to action I now use. Now I can cope with my situation, challenges and overcome my weaknesses by refreshing my mind setup instantly, looking at other perspectives to solve any problem. The cognitive skills gave me a temporary halt to greater and better control of all my actions and behaviors" (Holzel *et al.*, 2011) [11]. "I now know and know that possessing the cognitive skills, the tendency and the ability to make changes, and managing and controlling what is happening right now, understands clearly that it is entirely I who has the power to make changes and can also change ways of thinking." (Foroughi *et al.,* 2016) [12].

For several students, the problem-solving and conceptual knowledge acquired in school is basically inert. In some situations, acquired knowledge remains surface-bound problem features, as learned from school classes and textbook presentations. For example, Schoenfeld (1985) [13] observed that, in order to solve mathematical problems, all students basically rely on their standard knowledge of textbook patterns to solve problems rather than their knowledge of the intrinsic and strategic characteristics of the issues. If they are faced with problems that go beyond such patterns, they find a deficiency in their knowledge and mostly at a loss not knowing what to do. In different cases, students fail to use available resources to improve their abilities, skills and aptitude because they are unable to tap the exact resources. For instance, students do not gain the potential to improve their good reading writing skills, because they do not understand how these texts were developed by the authors. Scardamalia and Bereiter (1985) called them "knowledge-illuminating strategies," while they were ignorant of the need for professional and professional writing to organize and polish in-depth ideas on a written topic, while at the same time elaborating achievable goals in writing, considering what the audience might know or consider about the written topic, etc [14].

3.2. COMPONETS OF COGNITIVE SKILL ANALYSIS

Individual cognition is mindful and unaware, intuitive, conceptual, tangible and abstract. Such cognitive skill process analysis therefore includes components such as memory (working and long-lasting memory), processing speed (attention, mental imagery and action), logic (concept formation, pattern recognition, problem solving and association) and perception and reasoning in audio and video activities.

- **Memory:** It's not possible to retain all the information and knowledge in memory for long enough and long enough to remember them, in which case all the learning that has been done so far will suffer. Students always have a working and an enduring memory. The working memory allows learner to keep sequences intended for a small period of time, while the long-term memory allows them to retain and recall the data afterward. Be aware of some students' inability to remember one-step, simple, short instructions, or memorize things and events over a period of time, is better understand. The learning process can suffer if things like that happen. It is therefore important to impart additional activities to students to help their working and for long-term memory (Langer, *et al.,* 2015) [15].
- **Processing Speed:** It is the speed that is called processing speed that any learner can cultivate and manage data or information along with the time taken to complete the task. Otherwise, it is the length of time that information is received and answered accordingly. If the student's processing speed is low, then the data they store in their respective working memory will disappear

and get lost. The procedure to complete the task afterwards will be very difficult for the student, such as listening to and paying attention to the lecture, reading text messages, doing mathematical problems, solving science questions or something very simple as holding the topic of any discussion or conversation. It is necessary to be aware of the capacity of a student as well as the incapacity to swiftly move from one task to another. It is necessary to work and train students who continue to struggle with this type of memory retaining skills to effectively store and process information at a better speed in the younger age by training and cultivating their brain to transform and make better and stronger connections (Tarpin-Bernard & Croisile, 2012) [16].

- **Logic:** A student's ability to solve, understands, prioritizes, plan, and so on would differ if they lack reasoning and logic cognitive skills. Often, students ask, "What should I do next?" or they say, 'I don't understand the problem.' If any student is deprived of these skills, there will always be trouble completing academic activities, including problem-solving methods in subjects such as mathematics or any other subject or activity of comprehension. Students who often struggle to develop such skills need to be helped by involving challenges and connecting their minds with games of reasoning, logical activities (Cella *et al*., 2015) [17].
- **Auditory Perception and Reasoning:** The ability to understand and perceive what we hear is one more necessary cognitive skill the students should possess. The students should be in a position to read well and also spell words properly. They should clearly hear the differences in the sounds of each word. Students should be able to separate sounds, blend sounds, and thereafter, analyze the related sounds while reading the words. In case the student finds trouble in reading and spelling, then there is a need to improve their auditory sensitivity and perception. The crucial point to improve these skills by improving the consistency. Their brain should be strengthened and the capacity can be improved by challenging them frequently (Zenner *et al.,* 2014) [18].
- **Visual Processing Activities:** One of the additional cognitive abilities required to the students is to cultivate and possess the ability to sense faster and retain appropriate information in their visual imagery. To make it possible and to retain the observed and visual information, the students are required to remember pictures in their memory, understand the purpose and information. Various tasks and puzzles, solving method, mathematical problems need students to understand the basic concept, visualize the picture and envision in their memory. In case they fail to do so, they will also fail to comprehend or envision further information (Nuangchalerm, & Benjaporn, 2009) [19].

4. LITERATUREREVIEW :

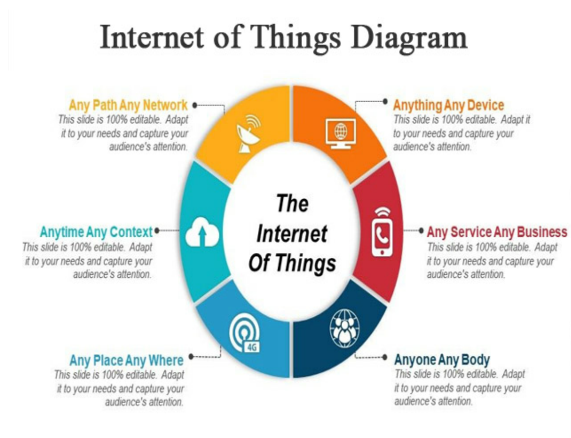
The phrase "Internet of Things," in short IoT, derives from the words "Internet" and "Things" to connect global systems over the Internet, interconnecting the entire computer network that uses standard TCP / IP suite to perform and help billions of users around the world. It acts as a network of the whole range of networks made up of millions of government networks, academics, research, hospitals, public, private, local and global businesses, by linking a wide range of optical, wireless, electronic, networking technologies (Kortuem *et al.*, 2010) [20]. The IoT concept commenced since 1982, at the time of when the coke machine was modified to connect to the Internet, due to which, the technology could report what are the contents of the drinks and also whether the drink temperature conditions were cold or at what temperature. Thereafter, in 1991, the IoT contemporary vision in the ubiquitous computing form was initially published by Mark Weiser (Weiser, 1991) [21].

4.1. IoT IN NUTSHELL

IoT is an abstract concept that can be perceived as anything around us that can be turned into a machine that provides useful information for the performance of varieties of analysis through huge data for humans. Using IoT, various objects, devices and people are connected to the internet and to other connected devices. Here data is sensed to emit automated virtual tasks that humans require. Using the key 'data' concept, IoT is used everywhere for further analysis, to take smart decisions such as automatic temperature reading from a specific location, distance covered by a vehicle being read by vehicle mileage meter etc. which saves money and time. These smart objects and systems can automate certain tasks, which are critical, time consuming, repetitive and dangerous. Basically, IoT is defined with 3 elements together: device, hardware and software computing, and connection to the internet. Any object could be connected to the IoT technology as an IoT device such as electro-machines, tools, job, buildings, clothing, school provisions, industrial tools, etc. Embedded system designed with hardware and software to give the devices functionality, control operations, and data storage. Any machines such as televisions, refrigerators, cell phones may have this type of system to give its work smartness. If it has to have internet access, the device becomes an IoT device. The type of connections depends on the purpose of design, for example by cable, wireless, satellite etc. That is, microcontrollers with sensors, actuators, and other circuit-built hardware can implement IoT along with programs written using some language for web-based control. It can capture and export data, or transfer it to cloud storage for further analysis. IoT devices can produce a lot of data depending on the user application such as who visits your home or temperature in your home etc. Now the manufacturers of these IoT devices will process this data in cloud such as Google Cloud, Amazon Web Services or Microsoft's Azure IoT suite. Using Wi-Fi, Bluetooth LE, LTE or ZigBee, Z-Wave or satellite connections, IoT devices can connect and share between themselves. Hook these devices together to execute automatic actions and controlling with a single interface is a difficult task.

Thus, IoT aspires to unify, amalgamate and merge everything in this world under one common infrastructure umbrella, providing us with complete control of objects and entities around us, but it will keep us educated and well versed with the situation of things. Future communication and computing develop dynamism in innovation of techniques from wireless to nanotechnology. This will tag each object to identify, automate, control and monitor. Internet of Things is the newest and advanced communication paradigm for creating a global network to seamlessly connect a large quantity of SOs- Smart Objects, or articles or entities. In a way, IoT allows the communication process from object to object to help SOs gather and exchange information and data without human intervention. IoT also allows human to object interactions and allows users to manage and control their respective SOs (Atzori Iera & Morabito, 2010) [22], Mashal *et al.,* 2015) [23].

4.2. APPLICATIONS OF IoT IN COGNITIVE TRANSFORMATION



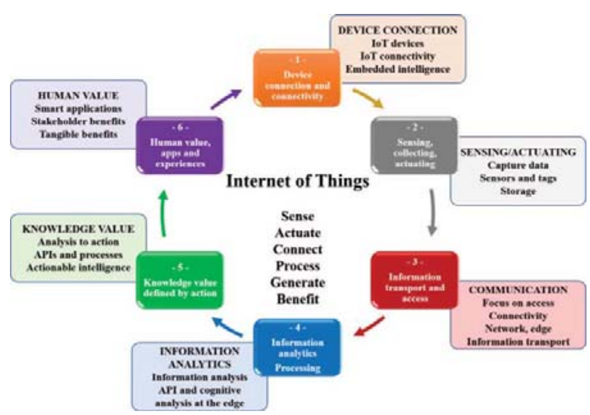


Fig. 1 & 2: Internet of things from connecting to advantages (Ramanpreet, & Soni, 2019) [24] (Vermesan *et al*., 2017) [25].

The change in perception of society and person occurs due to technology operations which are fundamental functions of IoT applications. Every device and task are automated (Figure 1), for example, by digitally connecting lifestyle to IoT technologies. Modern IoT technologies include sensors, actuators, and communication, local and distributed processing together (Figure 2).Immersive applications are built through the integration with intelligence of many industrial domains and environments which introduce cognitive transformation of IoT technologies and applications. The digital business environment and customer experience are developed using intelligence and business ecosystems with modern and better services (Vermesan *et al.,* 2017) [25].

Application logic chunks carried by smart objects senses the local situation and provide appropriate interaction with human users. These data are sensed, stored and interpreted for finding things happening inside the world, then acting alone and interacting with each other and exchanging information. Smart objects provide Distributed Architectural Model for IoT. The dual nature of smart objects views IoT as a technical system as well as a human centered interactive object. Author expects that smart object design will be expanded to include design for interaction with social aspects (Kortuem, *et al*., 2010) [20].

SOs includes heart rate test monitors, lighting intelligent objects, smart locks, power meters and various sensor types. It is estimated that the SO numbers which can be connected using IoT technology will reach 224 billion by 2022 (Al-Fuqaha *et al.,* 2015) [26] (Manyika *et al.,* (2015) [27].

Currently, many innovative applications and valuable IoT functions are provided by third-party organizations and companies. Telus provides several IoT functions, for example, from which any user can choose and subscribe immediately. Telus' application includes efficient fleet management, clever retailing, intelligent farming, smart restaurants, efficient waste management, dynamic construction and good public health and safety (Pang *et al*., 2015) [28].

Libelium is a popular IoT-applications provider. It covers various fields such as logistics, emergencies, security, smart ways of farming, smart health and farming, retailing, and home and residential computerization and automation (Asin 2011) [29].

Most of the IoT applications then became connected with SOs together. Based on user body experience, the smart objects can be used to interact humans with computers. To provide interfaces to communicate computers to humans, everyday object with computational capability may become smart (Rapp *et al*., 2015) [30].

A cognitive-computing device imitates human behaviour. Personalized connectivity and human-machine interaction systems are the cognitive computing AI development solutions. In fact, massive amounts of data generated from smart applications are collected from various sensors and cross-implemented cognitive computing systems, and finally stored in the cloud for real-time analysis. Cognitive IoT architecture collects data from these specific applications and analyzes them using cognitive computing and addresses the problems of scalability and versatility (Park*et al*., 2019) [31].

Student cognitive ability analysis requires IoT applications to be smart, intelligent in thinking and taking decisions. That leads to the incorporation of Cognitive computing with IoT and its applications. Cognitive computing involves providing the required working capacity for computers to solve very complex problems by themselves. Similar to humans, the actions of cognitive computers gained great advantage from experience, by understanding and learning improved ways of solving any problem with each action and encounter. When conventional systems and rules meet complex tasks, cognitive computing observes and satisfies the opportunity to broaden their knowledge (Bisht & Pooja, 2019) [7].

Due to the modern business needs of more important data, there is a cognitive computing necessity in the IoT. In the venues of the future smart IoT, all of them will find the need to use relevant data while making the right decisions, from startups to big business and homeowners, and they can do so after knowing the facts, instead of using their instincts. The Cognitive Computing process therefore uses the available data to respond to changes in order to make the right decisions based on specific learning processes from previous experiences compared to the regulated decision-making system derived from the rules. (Sanjiv, 2016) [8].

Cognitive 5G networks with IoT are looking for elastic delivery of broad services and strong operations in highly vibrant circumstances. At least one IoT node senses a spectrum sharing framework (multiband spectrum) for IoT in cognitive networks, the optimum number of channels per IoT node and the constraints on all channels(Ejaz & Ibnkahla, 2017)[32].

While IoT is instrumental in automation, lacks intelligence. By adding intelligence to it, IoT's full potential can be brought in, making the devices smarter to learn from the surroundings with dynamism, interacting with people through natural language, and making their own decisions autonomously. Cognitive IoT involved in a) Networking, dynamic change in communication performance with respect to the network condition b) Behavioral, IoT targets at learning, thinking and cognizing on its own c) Data analytics, data from technology are processed and analyzed to acquire knowledge for business growth. Therefore, CIoT is a system which is self-learned and self-managed (Pramanik, *et al*., 2018) [33]. Any general object can take advantage of IoT to make them think, learn and understand world. Human need and social behaviour, bridging objects and resources with cognitive computing, made things smart. He also attempted to improve smartness with regard to resource allocation, network function and service provisioning (Wu *et al*., 2014) [34].

Author designed wireless sensor and actuator networks allowing IoT solutions from the cognitive info communications perspective. IoT objects can interact with external systems, as well as between themselves. Two cognitive beings have the same cognitive capacities in intra-cognitive communication. Natural and artificial cognitive systems have different cognitive capabilities in inter-cognitive communication, but should work together effectively (e.g., a restaurant system based on a person and a digital menu) (Tervonen *et al*., 2014) [35].

Increasing the population and pollution caused by vehicles and many other sources every day, the environment faces common problem. The author addresses this level of pollution in a particular area, and how much greenery needs to be increased in that area. That will also help the formers and the polluted towns. Embedded C language and open source platform for Arduino IDE with both the hardware and software interaction used to develop Blynk App, an android app. This module will find components of the air and predict the trees that are to be planted in that area (Sarker & Sumathy, 2017) [36].

Increasing the variety of IoT devices in our environment, such as multi-sensors, mobiles and wearable, creates a major integration challenge with them. To address this, heterogeneous IoT devices are integrated and scaled with cognitive computing to build models of knowledge and a platform for self learning. This type of cognitive application might be used to diagnose building temperature anomalies (Ploennigs *et al.* 2017) [37].

Author(s)projected a content-based cognitive transmission approach for urban IoT applications supporting hybrid D2D / LTE networks. In this, captured video streams are used to detect remote objects and cognitive approach realizes the transmission strategy into match the encoding of video and processing structures. Numerical results show significant D2D connection throughput gain for a given application monitoring performance degradation when the video transmission interference process is fixed (Baidya&Levorato2016) [38].

Taking attendance in classroom is time consuming and monotonous process. Even students are physically present, not attentive will be the issue in attending the class too. It is tracked by an IoT solution developed based on Embedded Linux board named Raspberry Pi. This captures the image of student and store on cloud and analysed periodically with the help of Face Recognition API (Patil & Sachapara, 2017) [39].

The research study was developed in IoT, Long Range implementations and an FPGA-based system, which was used to find pH levels in their sweat on different human activities. This research has been successful in determining the physical condition of the patient (Cruz *et al*, 2019) [40].

4.3. FRAMEWORK OF IOT BASED COGNITIVE COMPUTING SYSTEM

Several predictions had been pointing to the relationship between IoT and cognitive computing since 2017. In order to maximize the value of cognitive analysis, IoT provides mass data to the size while cognitive computing and artificial intelligence are for speed. The technical acquisition of IoT is aggregated with external and internal sensor-driven company data sources. Sensitive time, synthesized smart data generated using machine learning framework, neural networks and artificial smart algorithms (Aasman, 2017) [41]. A cognition-based model of the CIoT network topology is structured for calculating and evaluating the advantages of the cognition based game theory. This principle comprises the core network (which consists of various routers such as access routers, wireless and transmitter routers) and the different parts of network access (including cognitive nodes, basic nodes or terminals). The new cognitive IoT test the current conditions of the network, which allow us to make more intelligent decisions and take appropriate steps to achieve better network efficiency (Zhang *et al.*, 2012) [42].

Heightened Analytic Specialization

IoT deployments have influenced more and more supply chain management and road optimization for distribution services, the booming domestic mobile and integrated vehicles smart technology market, and emergent wearable and ICU sensors for health applications. In applications, IoT's extension into cognitive computing drives the unique interest that cognitive analytical data produces inherently. This fact is especially evident in IoT healthcare deployments where AI is needed in massive quantities of unstructured data to locate "signals." Their predictive algorithms are important for evaluating which signals or irregular data are truly significant for each patient.

Intelligent Iterations

The value IoT produced is iterative in nature in cognitive computing. The information acquired by AI is used to optimize the predictive analysis leading to individual, individual applications. This iteration is an integral component of the cognitive machine. IoT data and other sources conducting the same behavior can be turned into cognitive analytical tools to provide even more tailor-made outcomes for the specific application. Iteration will also increase the accuracy of the forecasts of the empirical tests.

Human Tempered Machine Action

The absorption of IoT with cognitive computing finds two important data-centered outputs that are opposite in nature. They are automatic action by machines and decision-making based on humans. Both of these capabilities require decision-making automation.

Cognitive Analytic Data

The ubiquity of IoT comes from data called cognitive analytic data on its real-time operation. IoT systems with automation of cognitive computing build unparalleled accuracy in making the right decisions.

4.4. COGNITIVE APPRENTICESHIP APPROACH IN EDUCATION

To really apply and get the right results from the skills of the students, the primary thing is to understand the disposition and environment of the training and practice of the experts, and then to devise appropriate methods to follow and learn those practices appropriately. To do so, one must initially recognize the cognitive strategies that predominate and are applied centrally to the integration of knowledge and skills to accomplish and perform the meaningful task (figure 3). This type of system constructs the organizing ethics of proficiency, specifically in selected fields such as science, math, reading, and writing. The expertise practiced in such fields and then balance momentarily on the cognitive integration of strategies. This is best taught by methods that are traditionally used to transfer complicated skills and physical processes in apprenticeship (Chi *et al.*, 1989) [43].

IoT model includes Brain Library in Arduino, and the Mindflex for manipulating hardware devices with no previous expertise or experience, makes use quite easy. So, these communication models effectively can read and interpret the state of mind of a person from distance. Therefore, IoT and this module used together also in long distance learning (Padhi *et al.*, 2019) [45].

Teacher should find Cognitive acceleration needed by the students to study mathematics.

Thus, teachers should gather multiple related materials and provide interaction between pupils and pupils to develop intellectual development. IT environments may also contribute to this learning approach by creating the appropriate context for creating digital cognitive study environment. This research has detected a long-term impact on student achievement (Adhami *et al.*, 1998)[46].

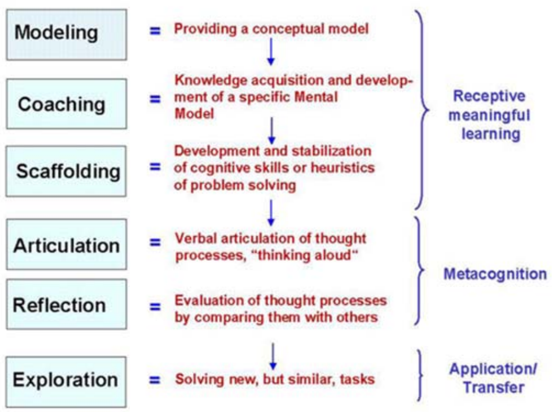


Fig. 3: The cognitive apprenticeship dimensions (Seel, 2002) [44]

Various sensors are used to simplify the role of the individual in developing intelligent learning. This requires education sectors connectivity with emerging technology. This combined model approach improves the student grasping level who hesitates in learning (Shinde & Bhangale, 2017) [47].

It presents a new smart classroom perspective model based on IoT. Quality education is enhanced with immediate feedback in the classroom on IoT technology. This model comes with monitoring and sensing technology to explore listener behaviours in the smart classroom. This information gathered gives insight into the level of classroom activity by correlating the existence and intensity of the sound and the movement. The student's response to class lectures is shown to enhance the teachers' quality. (Temkar *et al.*, 2016) [48].

In many applications, cognitive computing replaces existing calculators with sophisticated hardware such as the cloud infrastructure. These systems are seen as intelligent human. Therefore, these technologies applied to education with plenty of possibilities. Results with focus on cloud computing and platform as a service (Eclipse meets Bluemix) have been proven at a few Italian universities (Coccoli *et al.*, 2016) [49].

The most influencing factors in the process of human learning are technology, pedagogy, and social elements. Educational data mining (EDM) and learning analytics (LA) are two emerging areas for training and learning in cognitive computing. EDM is influenced by machine learning and data mining to help students, trainers and management with the big data help in education. Mining multimodal sensory learning data from various sources such as MOOCs, and Human-Computer Interaction (HCI), Intelligent Tutoring Systems (ITS), etc are used to evaluate affective state, performance, student learning pathways using EDM with other related disciplines such as LA, and learning theory and sciences. LA provides extensive learning settings, tools, and area of application, and techniques, both human and social factors. If EDM focuses on automation, LA is more holistic, and centered on people (Irfan & Gudivada, 2016) [50].

Development of cognitive abilities is possible through individual characteristics, past and current college experience. Authors (Kim, Y., et al., 2015) [51] succeeded in examining the differences between international and domestic students in these factors and patterns involved in the development of cognitive skills.

A method for measuring multilayer cognitive skills that requires study-related characteristics (SRCs) such as study schedule, family-related characteristics etc. of students to predict skills. The five factors that affect SRC include scheduling time for study, travelling between home and school, outing, free and parental relationships. Researchers found six mathematical models for the SRC, and tested the performance data sets of the student. This proved the best practice over existing cognitive ability measurement techniques (Ahmad *et al.*, 2018) [52].

According to the author, Cognitive skills are the professional tasks for teachers and students. Article uses results of an online survey of teachers, subsequent interviews and experimental work with students of engineering specialties in

English classes. These cognitive skills develop four types of knowledge: factual (facts and events), conceptual (theories and models), procedural (technology of activity) and metacognitive (awareness of critical thinking procedures). These higher order thinking, experience, and knowledge help students to solve problems by taking independent decisions and improve cognitive potential (Millrood & Maksimova, 2018) [53].

The report outlines the impact of the dynamic practice of Piaget through the cognitive level of the discourse of teachers, topics objectives, teacher issues and courses on the engagement of learners and encourages students to raise doubts (Ewing *et al.*, 2011) [54].

By preparing functional groups as course teams, e-learning using learning analytics is used to provide learners with an environment for preparing their study. A multi-module model of educational material, curriculum development strategies, cognitive status, behavioral analysis and personalization was developed to support learner and his learning experience (Troussas *et al.,* 2020) [55].

To flourish the online learning environment (OLE), the dynamic nature of education requires much cognitive skill. The cognitive augmentation-assisted technology used here is an interactive learning tool provided with unlimited learning materials for learning, engaging, and building cognitive skills. Theoretically, this OLE is proposed to nurture cognitive abilities in chemistry amongst students. IoT technology is used to generate large amounts of data collection and predictive data analysis is used to nurture critical thinking, problem solving skills, etc (Rosli *et al.,* 2020) [56].

Cognitive algorithms are the cognitive computing principal spirit. This type of computing requires a massive amount of data and analysis to enable the human being to answer questions as well as make decisions. Cognitive computing can address complementary aspects, such as hypothesizing and validating correlations via evidence. Cognitive computing is progressing rapidly through data mining, pattern recognition, and natural language processing to develop technology to support our ability to answer complex questions (Sheth, 2016) [57].

The key factor defined by the use of the Ontology-based cognitive support system (OBCSS) is the assessment of student mental efforts in educational setting context. This study model also discovers the scales used in education to collect data on engagement behaviour and navigation (Kaya & Altun, 2018) [58].

Developmental relationships are observed by author at the pre-kindergarten year level of children. Result showed that growth in both general cognitive processes, such as attention control and work memory ability, and basic skills such as literacy and numeracy construct reading, writing, and functional achievement. This is checked using setting for teaching mathematics. Result also showed that growth triggered by working memory and control of attention leads to improving literacy and numeracy skills in these kids (Welsh *et al.*, 2010) [59].

Effective functions are cognitive processes that allow for the development of behaviour to achieve goal due to maturation and environmental simulation. The author studies interaction and the connection between student and teacher. Teacher will seek to encourage the student's positive emotional learning approach and cognitive processes which are the essential needs of teaching in the classroom. Teacher shall study the personality, thoughts, desires and expectations of the pupil. This helps the instructor improve teaching efficiency for involving students in discussions and classroom behaviour. Additional feedback and experiences make the teaching perfect for achieving better learning results for students (Vandenbroucke *et. al.*, 2018) [60].

4.5. IOT FOR PERSONALISED LEARNING

Continuous monitoring and analysis of the different students' state and activities will be achieved through information sensors and processing platforms, improving the quality of learning process. This encourages feedback from various students about learning process. IoT allows the expansion and enhancement of the study environment to be accomplished quickly through smart educational process with effective decisions about our daily lives (Abdel-Basset *et al.*, 2019) [61].

Applications for an IoT device are being developed in classroom. These devices are invoked for requesting queries related to the subject of the textbook using student and teacher voice. This instrument takes the sound as input and study is performed with artificial intelligence and machine learning to provide the audience correct criticism. This way the classroom is made interactive in order to study the content of the textbook with fun. These IoT applications are used before students, and allow feedback to be received (Ali, 2018) [62].

Using IoT, further teaching and learning processes are improved. This provides a platform for learner to study better, and educators to further effectively perform their duties. IoT technologies can include scalable, engaging and quantifiable training to meet the students' large number of educational needs (Gul *et al.*,2017) [63].

Author used IoT ready platform with heterogeneous devices which host the learning materials in personalised learning. Sensing devices will capture the behaviour and way materials are handled during interaction with them. It is implemented in the form of game installed on mobile devices and with robots. Here pieces of knowledge called learning atoms towards a learning goal to be reached by a learner are set by a tutor. The sequence of learning activities set by teacher may differ from that of each learner. This personalization may depict the linear graph to show the learning actions difficulties involved (Spyrou *et al.*, 2018) [64].

IoTutor a web-based application that allows chat based interaction with learners using natural language, either text or speech form. This IoTutor was used by Linnaeus University students for a period of two weeks participated in finding the IoTutor's simulation, effectiveness, perspicuity and novelty. A collection of training questions and materials offered sub-optimum qualitative answers to IoTutor. Author suggested that assuming tutor is trained with a larger digital library of publications to produce answers of high quality. In his model, author also provided use of cloud services such as speech-to-text, text-to-speech, discovery, and natural languages (Memeti *et al.*, 2018) [65].

Teachers need to plan varied, good-quality lessons so that all students can access the information. Planning lessons based on the differences in the student's academic ability gives better results on student achievement than on their preferences of learning style. Teaching and learning techniques should be designed to personalize learning in various ways to provide an effective learning experience for each student. (Hulme, & Allcock, 2010) [66].

Future classrooms should be intelligent in providing high teaching and learning with a smart learning environment. Intelligence reflects resources and services in future classrooms with hardware and software technologies to improve the individual learning and reasoning skills of learners (Weidong, *et al*., 2012) [67].

Intelligent ambient is designed using IoT to give mechanical feedback on the lecture excellence based on certain measures. A smart classroom is created that has a sensing and monitoring technology to discover leaner behaviour. This helps the teacher observe the student's response to class to improve the quality of his teaching (Gligorić, *et al*., 2012) [68].

IoT Resource Management System (RMS) is an area of research. This allows any physical things to be made as smart to help human beings to simplify and monitor with pinpoint accuracy. Therefore, smart classroom is implemented for monitoring students as well as management of tutor tacking. These in turn affect the student's ability to attend the class regularly (Enugala, *et al*. 2018) [69].

The students are using new technologies in the field of education to take projects and enlightening activities in the study environment. The author presents the requirement to integrate IoT with ICT technologies to improve learning in elementary and secondary school (Mrabet & Ait, 2017) [70].

Service oriented IoT framework based on XMPP is developed to implement smart future classroom. This makes students and teachers to interact each other in the classroom, and campus. This supports unicast, multicast and broadcast message service mechanism with security capabilities (Chang, *et al*., 2015) [71].

Author designed IoT classroom applications to access control and enhance teaching and learning. It also helps monitor the health and real-time monitoring of students in classrooms (Bagheri & Movahed, 2016) [72].

The article presents Smart Classroom's built ontology, helps to explain and evaluate the existing smart classroom structure and describes characteristics, operation, hardware, software, education and learning- activities of learning of the next generation. This modern approach to learning, education, learning processes and practices, organizational preparation, increases user productivity and success by providing the services with consistency (Uskov, *et al*.,2015) [73].

In the classroom the student interests are evaluated using certain parameters. Facility of use, perceived utility, accessibility, architecture, multiple sources and reflective thinking etc. are just a few features that will lead to creating a smart classroom to meet students' individual needs (MacLeod, *et al*., 2018) [74].

Northern Thailand students are studied using an OBSY (Observation Learning System) prototype with primary science education as their goal. This model is designed to work with ICT environment using a sensor, mobile, and a self-contained DIY Wi-Fi network. Students found the best interaction outcomes with this OBSY and even studied experiments in science. Questionnaires and interview sessions are performed using OBSY system and are made to engage students in learning (Putjorn, *et al.* 2015) [75].

The outcome of multi-module model experiment was satisfied and promised to students, educators and administrators. By developing curriculum mapping and learning inventions, students will be helping in personalized learning. This will provide high-value metrics for measuring the efficacy of teaching techniques, learner involvement in classrooms and the efficiency of technology learning processes (Troussas *et al.*, 2020) [55].

4.6. USE CASES OF IOT IN COGNITIVE SKILL ANALYSIS

In terms of both size and reach, there is a rapid rushing in the development of connected devices and a greater emphasis on interoperability. Rapid advances in various networking technologies support hyperconnectivity (Vermesan *et al.*, 2017) [25]. The next stage of IoT data evolution will require integration of a wider data variety with more advanced data analytics. Applications such as smart buildings and connected vehicles are just a few examples that will likely deploy IoT data such as smart IoT (Sheth, 2016) [57].

a. In Agriculture

Intra and inter cognitive communication model developed by an author with various interfaces benefited to farmers or farming advisors to handle, update and analyse the data related to agriculture. This interface has additional functions that allow others to view specific information such as crop yield, maps of the nutrient balance on fields, etc (Tervonen *et al.*, 2014) [35].

b. Smart environment

Increasing the population and pollution caused by vehicles and many other sources every day, the environment faces common problem. The author addresses this level of pollution in a particular area, and how much greenery needs to be increased in that area. That will also help the formers and the polluted towns. Embedded C language and open source platform for Arduino IDE with both the hardware and software interaction used to develop Blynk App, an android app. This module will find components of the air and predict the trees that are to be planted in that area (Sarker & Sumathy, 2017) [36].

c. Diagnosis of high temperature

Building rooms are provided with temperature sensors and heating systems. Abnormal conditions such as too low temperature, two degrees below the set point are monitored and detected. For all such rooms, the analytical function captures this detection and diagnosis with semantics model (Ploennigs *et al.*, 2017) [37].

d. City monitoring IoT applications

Heterogeneous networks are installed to support computing and data processing to monitor cities. This is controlled and monitored by a cognitive interface mechanism based on content implemented in urban areas using IoT. This interface uses camera-generated video data stream to detect objects in cities at a remote location. (Baidya & Levorato, 2016) [38].

e. Smart Classroom

Classroom attendance and attention of student is captured periodically by IoT enable camera. This captured image of student are stored on cloud and analysed periodically with the help of Face Recognition API (Patil & Sachapara, 2017) [39].

f. Internet of Tangible Things

A new, non-traditional Tangible User Interface (TUIs) is being developed to connect physical set of objects with the Internet connectivity capability to monitor the activity of children in real time. With IoT technology, Internet of Tangible Things (IoTT) can help children develop skills that include social, emotional, cognitive and visual skills. This model has proved its work with best results on hearing impaired children (Cano *et al*., 2020) [76].

g. smart classroom

Using IoT a successful smart classroom system is implemented with smart teaching aids and control of appliances inside the classroom. To increase student interest in studies, integration is developed between teacher perception and student perception (especially in rural areas). This app is installed on teacher's mobile and can control in-class electrical appliances. With enhanced teaching and learning experience this will affect secondary school education (Borse & Patil, 2019) [77].

h. Pre-Cognitive Impairment using pH Level

The research study was developed in IoT, Long Range implementations and an FPGA-based system, which was used to find pH levels in their sweat on different human activities. This research has managed to find out the physical condition of the patient. The experiment was done by taking 3 different sweat conditions with temperature variants from 5 individuals to find the pH level information. Studies have also shown that the application of emerging technologies such as IoT and LoRa in real-time data transmission to facilitate immediate remedies and proper medical care (Cruz *et al*., 2019) [40].

i. Wearable Devices

Innovations are driving wearable technology into health, education, intelligent cities and intelligent vehicles IoT applications. Wearables' favorite position has drawn tremendous attention and preferences (Vermesan *et al*., 2017) [25].

j. Smart Chair

Author suggested making physical chair as smart, by interconnecting smart devices such as sensors, RFID readers, and a wireless communication devices and applicable mobile application. This works with cloud storage to help the instructor and others to record attendance of students (Enugala, *et al*., 2018) [69].

5. SUMMARY OF RELATED WORK :

Table 1: Review of findings presented by different authors between 2010 and 2020.

SNo	Author(s)	Year	Inventions/Findings/Results
1	Hulme, & Allcock [66]	2010	Teaching and learning techniques should be designed to personalize learning in various ways to provide an effective learning experience for each student.
2	AtzoriIera & Morabito [22]	2010	IoT allows the communication process from object to object to help SOs gather and exchange information and data without human intervention.
3	Kortuem *et al*. [20]	2010	Author developed Distributed Architectural Model for IoT using smart objects and design will be expanded to include design for interaction with social aspects.
4	Welsh*et al*. [59]	2010	Developing thinking skills and increases in preparation for low income children in public schools
5	Holzel *et al*. [11]	2011	Attentiveness leads to increased density of gray matter in the regional brain
6	Ewing *et al*. [54]	2011	Model aimed to describe the influence of Piaget's dynamic knowledge using the cognitive mode of teacher discussion, teacher questions, course agenda, and

			percentage of the lecture taken during class hours.
7	Weidong, *et al* [67]	2012	Intelligence reflects resources and services in future classrooms with hardware and software technologies to improve the individual learning and reasoning skills of learners
8	Gligorić, *et al* [68]	2012	A smart classroom is created that has a sensing and monitoring technology to explore leaner behaviour.
9	Chen& Jin [6]	2012	A model is to help students simplify their learning skills and, to independently transfer those skills for the better cause when faced with new situations
10	Tarpin-Bernard & Croisile [16]	2012	It is necessary to effectively store and process information at a better speed in the younger age by training and cultivating their brain to transform and make better and stronger connections.
11	Zhang *et al*. [42]	2012	IoT with intelligence can apply existing network conditions, analyze apparent knowledge, take smart decisions, and implement suitable actions aimed at maximizing network performance.
12	Tervonen *et al*. [35]	2014	Natural and artificial cognitive systems have different cognitive capabilities in inter-cognitive communication, but should work together effectively to implement applications such as a restaurant system based on a person and a digital menu.
13	Wu*et al*. [34]	2014	The author attempts to find CIoT, the ability to bridge the objects and resources with behaviors of the society such as human demand, social behavior etc.
14	Chang, *et al* [71]	2015	Service oriented IoT framework based on XMPP is developed to implement smart future classroom.
15	Uskov, *et al.* [73]	2015	Ontology based modern approach to learning, education, learning processes and practices, organizational preparation, increases user productivity and success by providing the services with consistency.
16	Putjorn,*et al.* [75]	2015	Students found the best interaction outcomes with this OBSY and even studied experiments in science.
17	Langer *et al*.[15]	2015	Found the importance to impart additional activities to students to help their working memory and long-term lasting memory.
18	Cella *et al*. [17]	2015	Students who often struggle to develop such skills need to be helped by involving challenges and connecting their minds with games of reasoning, logical activities
19	Mashal *et al*. [23]	2015	IoT also allows human to object interactions and allows users to manage and control their respective SOs
20	Al-Fuqaha *et al*. [26]	2015	SOs includes heart rate test monitors, lighting intelligent objects, smart locks, power meters and various sensor types.
21	Manyika *et al*. [27]	2015	It is estimated that the SO numbers which can be connected using IoT technology will reach 224 billion by 2022
22	Pang *et al*. [28]	2015	Telus' application includes efficient fleet management,

			clever retailing, intelligent farming, smart restaurants, efficient waste management, dynamic construction and good public health and safety.
23	Rapp *et al*.[30]	2015	Based on user body experience, the smart objects can be used to interact humans with computers.
24	Kim *et al*. [51]	2015	Authors found the differences between international and domestic students in the factors and patterns involved in the development of cognitive skills.
25	Bagheri & Movahed [72]	2016	Designed IoT classroom applications to access control and enhance teaching and learning.
26	Sanjiv [8]	2016	Due to the modern business needs of more important data, there is a cognitive computing necessity in the IoT.
27	Baidya & Levorato [38]	2016	Content-based cognitive transmission strategy for urban IoT applications supporting hybrid D2D / LTE networks. It is used to monitor cities where a camera-generated video data stream is remotely processed to detect objects.
28	Temkar *et al* [48]	2016	Presents a new smart classroom perspective model based on IoT.
29	Coccoli *et al* [49]	2016	The technologies applied to education with plenty of possibilities on cloud computing and platform as a service have been proven at a few Italian universities.
30	Irfan & Gudivada [50]	2016	Educational data mining (EDM) and learning analytics (LA) are two emerging areas for training and learning in cognitive computing.
31	Sheth [57]	2016	Cognitive computing uses cognitive algorithms requires a massive amount of data and analysis to enable the human being to answer questions as well as make decisions.
32	Mrabet & Ait [70]	2017	The author presents the requirement to integrate IoT with ICT technologies to improve learning in elementary and secondary school.
33	Vermesan *et al*. [25]	2017	Immersive applications are built through the integration with intelligence of many industrial domains and environments which introduce cognitive transformation of IoT technologies and applications.
34	Ejaz & Ibnkahla [32]	2017	Cognitive 5G networks with IoT are looking for elastic delivery of broad services and strong operations in highly vibrant circumstances.
35	Sarker & Sumathy [36]	2017	Embedded C language and open source platform for Arduino IDE with both the hardware and software interaction used to develop Blynk App, an android app and module will find components of the air and predict the trees that are to be planted in that area.
36	Ploennigs *et al*. [37]	2017	Heterogeneous IoT devices are integrated and scaled with cognitive computing to build models of knowledge and a platform for self learning. This type of cognitive application might be used to diagnose building temperature anomalies.

37	Patil & Sachapara [39]	2017	IoT solution captures the image of student and store on cloud and analysed periodically with the help of Face Recognition API to track the student attention in classroom.
38	Aasman [41]	2017	Sensitive time, synthesized smart data generated using machine learning framework, neural networks and artificial smart algorithms.
39	Shinde & Bhangale [47]	2017	The use of IoT will assist to develop smart education with emerging technology. This combined model approach improves the student grasping level who hesitates in learning.
40	Gul *et al.* [63]	2017	IoT provides a platform for learners to study better, and educators to effectively perform their duties.
41	MacLeod, *et al.* [74]	2018	A few features and technologies will lead to creating a smart classroom to meet students' individual needs.
42	Pramanik, *et al.* [33]	2018	By adding intelligence, IoT's full potential can be brought in, making the devices smarter to learn from the surroundings with dynamism, interacting with people through natural language, and making their own decisions autonomously.
43	Enugala, *et al.* [69]	2018	Smart chair- This allows any physical things to be made as smart to help human beings to simplify and monitor with pinpoint accuracy.
44	Millrood & Maksimova [53]	2018	Article uses results of an online survey of teachers, subsequent interviews and experimental work with students of engineering specialties (cognitive skills) in English classes.
45	Kaya & Altun [58]	2018	The key factor defined by the use of the Ontology-based cognitive support system (OBCSS) is the assessment of student mental efforts in educational setting context.
46	Vandenbrouck*et.al*. [60]	2018	The author studies interaction and the connection between student and teacher are achieved using effective functions.
47	Ali [62]	2018	Applications for an IoT device are invoked for requesting queries related to the subject of the textbook using student and teacher voice. It helps to improve personalized learning.
48	Spyrou *et al*. [64]	2018	Author used IoT ready platform with heterogeneous devices which host the learning materials in personalised learning.
49	Memeti *et al*. [65]	2018	IoTutor an web-based application platform allows chat based interaction with learners using natural language, either text or speech form.
50	Cruz *et al*. [40]	2019	IoT based Long Range implementations and an FPGA-based system, which was used to find pH levels in their sweat on different human activities. This research has been successful in determining the physical condition of the patient.
51	Padhi *et al*. [45]	2019	IoT model includes Brain Library in Arduino, and the

			Mindflex, can read and interpret the state of mind of a person from distance. Therefore, IoT and this module used together also in long distance learning.
52	Abdel-Basset *et al.* [61]	2019	Continuous monitoring and analysis of the different students' state and activities will be achieved through information sensors and processing platforms, improving the quality of learning process.
53	Borse & Patil [77]	2019	Using IoT a successful smart classroom app implemented with smart teaching aids and control of appliances inside the classroom. To increase student interest in studies, integration is developed between teacher perception and student perception (especially in rural areas).
54	Bajwa & Gula [10]	2019	Students learn to create divided attention, to execute multitasking. When students learn to do this work, they will develop higher cognitive functioning skills, which will help them to succeed in school.
55	Park *et al.* [31]	2019	Cognitive IoT architecture collects data from smart specific applications and analyzes them using cognitive computing and addresses the problems of scalability and versatility.
56	Bisht & Pooja [7]	2019	The incorporation of Cognitive computing with IoT and its applications provides the required working capacity for computers to solve very complex problems by themselves.
57	Shammar & Zahary [1]	2019	Unique identifiers (UID) and capable of transferring and relocating data via the Internet network in the absence of human-to-computer involvement or without human-to-human interactions.
58	Rosli *et al.* [56]	2020	The online learning environment (OLE), the dynamic nature of education requires much cognitive augmentation-assisted technology and used as an interactive learning instrument provided with infinite study materials for learning, engaging, and building cognitive skills.
59	Troussas *et al.* [55]	2020	The multi-module model experiment was satisfied to develop curriculum mapping and learning inventions, and personalized learning.
60	Cano *et al.* [76]	2020	Internet of Tangible Things (IoTT) can help children develop skills that include social, emotional, cognitive and visual skills. This model has proved its work with best results on hearing impaired children.

6. DISCUSSION & FUTURE WORK :

In order to truly apply and get the right outcomes from the student skills, it is mainly a matter of understanding the nature and the atmosphere of the teaching and practice of experts. In order to achieve this, the cognitive strategies which prevail, and which are essential to the integration of information and skills, must initially be recognized. This type of system creates organizational expertise principles, especially in certain fields like science, mathematics, reading and writing. One major buzzword happens to be the Internet of Things or IoT in the present Information Technology scenario. To put it another way, the whole future of global technology will swing around the Internet of Things, which is bound to transform the virtual objects of this real world into so-called intelligent virtual and implicit objects. This ability to code, identify and track various objects has enabled many industries and companies to perform more efficiently, speed up procedures, reduce all kinds of human or other errors, prevent all kinds of theft, and incorporate flexible and complicated organizational processing structures and techniques to implement IoT (Ferguson, 2002) [78]. This research and literature review provides certain vital insights regarding the benefits and importance of developing and implementing cognitive learning skills of students using IoT. They are merely a few brain-training and cultivating skills that the students must learn and carry out in their daily tasks. Providentially, those students who struggle with gaining these skills, they have the right opportunity to develop and boost their cognitive functioning skills with a specific repetitive practice and applying brain challenging puzzles and games (Rabipour & Raz, 2012) [79].

With the help of technology, future work of this study may think about the techniques of thinking skills and development towards motivation. For student-independent study, IoT tool with technology invention is required to convert material into their desired format so that students can engage in material and personalized learning. Also, by incorporating modern technologies that allow students to address and reflect on their own learning strength and weakness, they need to find the most effective teaching and learning techniques. In future, the new digital society would create virtual schools that rely on Internet artifacts to promote off-campus learning and increase modern learning participation.

7. RESEARCH GAP :

The integration of millions of objects and functions into the environment allows for interplay and collaboration, enabling an optimal and efficient service. These are new research challenges that will benefit the environment, the economy, the people and society (Rampasso *et al.*, 2020) [80]. Future investigations into cognitive education in the classroom will combine IoT and new emerging teaching and learning technologies with needs, ideas, learning strategies and skills. This also includes the change to new technologies in education in the classroom infrastructure. Training for teachers, students, parents and others in the educational environment is obligatory in this learning approach. From our review we found that IoT-based cognitive applications generate information for users with bulk data from diversionary sources and allow decision-making by themselves. In order to improve the capacity of students, like writing, reading or both, future smart IoT applications are necessary. The IoT module for teachers is also expected to read and analyze the student's mood, attention and quality during learning to implement new teaching strategies. Some of the research gap issues we found are:

Research Gap 1: *IoT based applications to enhance personalized learning for student*

Education strategy is followed in most schools "one size fits all." Each student's learning potential is different. In various places, they learn various things. Education organizations typically receive limited funding, employment problems and poor attention to real education. This technology helps to manage costs, improve education quality, vocational development and improve facilities management. A new teacher application model is therefore developed and a 'learning program' based on skills, interests, learning practices and previous knowledge can be prepared. For student-independent study, IoT tool with technology invention is required to convert material into their desired format so that students can engage in material and personalized learning.

Research Gap 2: *IoT based cognitive computing tool for teacher(s)*

The right decisions are to be made by intelligence. Learning in the classroom involves multiple factors of attention, mood, abilities, theoretical or practical expertise and knowledge. The curriculum also requires changes in the subject of teaching and the strategy. For this reason, teachers should find an IoT application to store various student data collection, storage and analysis equipment for a dynamic curriculum and teaching plan.

Research Gap 3: *Smart Objects or smart IoT applications in classroom teaching*

New internet age is delivering some information at any time. Students want to learn more about the topics. The Wearable IoT application helps teachers to read feedback, analyze and improve teacher methods and strategies to provide students with more knowledge. Therefore, the teacher is physically not replaced with smart objects instead.

Research Gap 4: *Requires understanding the activities and behaviors of teachers to promote effective functions of students.*

Review finds evidence suggesting the contribution of teacher and student experiences to cognitive-based learning is most significant. Potential work will also concentrate on that the responsiveness of the teachers is likely to be more successful than enhancing the organization of classrooms. An IoT system with emerging technology to be built to identify tasks and behaviors for teachers to improve the cognitive actions of the students.

8. RESEARCH AGENDA :

(1) What procedures or approaches were used to test student and instructor cognitive behaviors?
(2) What IoT framework can be suggested for integrating student and teacher cognitive habits into classroom education?
(3) What new technologies can be proposed to introduce smart classroom to enhance personalized learning by taking cognition factor into consideration?
(4) What IoT Technology can be suggested for educational institutions that the software, hardware and networking and storage complexities?
(5) What teaching-learning strategies have evolved in the customized educational platform regarding the IoT system, and will continue to improve?
(6) What are the challenges in classroom teaching automation of emerging technologies contained in smart objects?
(7) What IoT architecture suggests low-cost technologies and high benefits for cognitive IoT classrooms, especially in rural areas?

9. CONCLUSION :

This paper focuses on the future impact on the education sector of IoT technology. Learning is an unavoidable human activity. Technology made learning things and concepts simpler by offering resources and facilities for its assistance. The goal of this study is to take advantage of evolving IoT technologies to create smart classrooms with student cognition. The challenges in classroom education are being studied and designed to provide the teachers and students with a solution with IoT applications required. Therefore, our future work should create an IoT framework to enhance the education in classrooms.

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