



Smart Learning in the Ecosystem: Examines Smart Learning Structural Design Features Considering IoT and IoB

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Abstract

The Internet of Things (IoT), IoT-Education, and smartness are emerging technology used in Industry 4.0 to enable smarter education systems that can be adapted to different learners. Using IoT as an acceptable and useable infrastructure is one of the leaders' innovative strategies. It is an intelligence enabler that will be integrated into many essential parts of the future world. This study looks at the key elements of smart learning structural design, such as IoT and IoB (internet of behavior), as well as the major issues that must be addressed when creating smart educational environments that allow for personalisation. To incorporate smart learning environments into the learning ecosystem and educational contexts, IoT, IoB, and cloud services for a smart education ecosystem must be used to orchestrate formal and informal learning. This study emphasizes smart learning paradigms and smart learning environments and the importance of involving future users in the design process to broaden understanding of the design and implementation of innovative systems for smart learning.

Keywords: Internet of Things; Internet of Behavior; Smart Education; Industry 4.0;

1. Introduction

Distance and time are no longer barriers to a quality education. Technology's rapid development has influenced the structure and operation of today's schools. In short, IoT may link many different kinds of gadgets to the web. Computers might be programmed to act and behave like people in a wireless environment with the use of machine learning and AI. These innovations have an impact on every aspect of human life. They have a wide range of potential applications in many different sectors, including but not limited to education, industry, healthcare, transport, smart town planning, and energy[1], [2].

The educational system is not immune to the effects of technological progress. The influence of the Internet of Things on education is immense. Teachers have found new ways to liven up class thanks to the Internet of Things. Because of the Internet of Things (IoT), learning is now more available to people of all ages, backgrounds, and skill levels. Immersion is an effective strategy for picking up a new tongue since it gives continuous exposure to the language in use. Learning a language in its home country has several advantages, including easy access to the speaker's comments. It's difficult to replicate these settings outside of the nation, but with the help of IoT, we can create simulated learning spaces where learners can be monitored and teachers can provide immediate feedback. IoT Internet of Things networking may help facilitate task-based education. Students gain knowledge via hands-on experience, and their professors may use automated feedback and reinforcement to boost their performance. Students with disabilities have benefited greatly from the IoT because of the accessibility features it has introduced[3], [4].

The advancements in Artificial Intelligence (AI), Machine Learning (ML), and the IoT have had a profound effect on academic study and classroom instruction. Using AI and ML, we may perhaps automate tasks like taking roll and assigning grades. The demands of the individual student may be accommodated by instructional software. With the help of IoT and AI, students may take their e-learning courses whenever and wherever they choose. Students may also take part in online forums and discussion groups to disseminate and debate information. Due to the rapid proliferation of information, the role of education in disseminating it has become more critical during the last several years. As a result of this altering paradigm, students have to finish their schooling in a variety of different methods. Consequently, a learning environment is established that actively promotes originality. Learning is made more engaging and individualised for each student via the use of a variety of technologies of information and communication. Constantly monitoring students' physical and psychological states and activities and providing immediate answers on their active learning is possible with the use of information sensing devices and information processing platforms. The IoT is an ambitious initiative with the potential to significantly improve people's quality of life, happiness, and efficiency. The IoT has the potential to facilitate the expansion and enhancement of critical infrastructure for a broad variety of industries. The goal of XAI is to explain to the user exactly what an AI system performs and why, allowing the user to have a firm grip on the inner workings of the system. That makes it much easier to observe, assess, and shape user actions[5]–[7].

While IoB has the potential to be utilised to monitor student behaviour that affects attainment, progression, and performance, very little research has explored how to use IoB to personalise learning material. In this research, we will show how an explainable artificial intelligence (XAI) and IoB paradigm may be used to tailor course materials to individual students' knowledge and understanding, as well as streamline the process of monitoring their academic growth. In this study, we combine the IoB with XAI to create frameworks that are both trustworthy and easily grasped by students in the classroom, where users' habits are formed. To maximise learning absorption and robust academic advancement, an IoB-based XAI-based school system is provided to assist students and instructors in shifting toward an environmentally friendly conduct. This framework may be used to provide smart, adaptable education by integrating Internet of Things (IoT), Artificial Intelligence (AI), Data Analytics, Personality Psychology, and Cross-Approximate Intelligence (XAI) methods[8], [8], [9].

1.1 Overview of the IoB and IoT

The term "Internet of things" (IoT) refers to a system in which interconnected physical devices gather and share data and information through the Internet. With IoT, the connected devices may communicate with one another and analyse data on their own, while cloud storage continues to expand. Customers' actions, wants, and expectations may be better understood via this "Internet of behaviour" of collected data (IoB). Both client preference and the supply chain will be altered by the IoB. Some customers are hesitant to provide information, but many are happy to do so if doing so would help them in some way. It guarantees, among other things, that they may alter their brand, increase sales to consumers, and better serve their customers. The end goal is to increase dependability and consistency, and in theory, this may be achieved by gathering information on every facet of a consumer's existence[10]–[12].

Interaction on Board (IoB) let developers see how users will engage with an application before it is built. Their requirements are taken into account during development as this technology is utilised to create an intuitive and useful interface for the programme that is simple to navigate. Additionally, it may allow for integrated design maintenance, social media integration, and the personalization of software across many channels and with the sending of individual notifications. Users' actions may be deduced from the information gathered by the app's code. Further, it may encourage and inspire consumers to maintain the behaviour outlined in consumer alerts[13]–[15].

The goal of the IoB is to provide a behavioural and psychological explanation for the information gleaned from people's online activities. Data interpretation and application to the creation and promotion of novel psychologically-informed consumer products are discussed. Among IoB's many benefits is the ability to analyse consumers' spending habits across all platforms. Data on how people employ various pieces of kit and utilise various products may be simply analysed. It gives precise information about the buyer's position in the purchasing cycle. Big Data allows for the collection of information from a wide variety of sources. With the help of this technology, the user is provided with additional opportunities for constructive interaction[16]–[19].

Many businesses now provide IoT solutions to consumers, bridging the gap between individuals and the behavioural Internet. This extends the Internet of Things by linking previously isolated devices to a plethora of fresh data sources. Many companies obtain data on people who aren't their customers by having them trade in linked gadgets. A knowledge-gathering centre, both interfaces are a result of the technology that surround us. An individual's online and physical movements may be tracked in real-time by a single Smartphone using this technology. Phones, computers, and workstations are all linked together via the usage of gadgets around the house, such voice companions, distant cleaning, and car cameras. In addition, IoB integrates individual-centric technologies already in use, such as face recognition, location monitoring, and big data. Science, computer science, and behavioural psychology all come together in this. The IoB aims to monitor and guide behavior by means of cutting-edge technological and machine-learning advancements in the areas of monitoring, analysis, perception, and response. In order to motivate employees to meet a set of predetermined organisational goals, their actions are monitored and rewarded when they meet the benchmarks set for them[20]–[22].

1.2 Internet of Behaviour

In the past, researchers would often employ focus groups to analyse customer sentiments and preferences. How customers from different walks of life and experiences react to a service or item depends on a variety of factors. Following the completion of the sample study, the level of confidence in the company's provision of the service or product in question may be established. Several individuals consider 2012, when "Gothe Nyman," a professor of psychology, proposed collecting detailed information on customers' usage and behaviour as they interact with the IoT, to be the beginning of the IoB. However, in order to evaluate customer data for business goals, one must rely on an automated ecology of analytical processes that monitor, collect, and try to analyse the enormous amounts of information we generate via our digital and Internet activities[23]–[25].

In 2021, IoB will likely be one of the most talked-about technological developments. The COVID-19 epidemic is largely to blame for IoB's rise to prominence, since it has altered consumers' relationships with brands and prompted a reevaluation of companies' methods of reaching out to them. The concept behind IoB comes from the field of psychology, with the end goal being the accurate analysis of data and the use of that knowledge in the creation and promotion of new products. Using principles of behavioural psychology, the IoB attempts to make sense of information gleaned from users' digital footprints. From a psychological standpoint, it seeks to explain how to decipher data and use that understanding to the creation and promotion of novel products. Sometimes this new trend impacts Quality Infrastructure since more and more businesses may increase their connection, raising consumer expectations. As the pyramid shows, the Internet of Things converts data into information, and the Internet of Things and People (IoT&P) might convert our understanding into true wisdom in figure 1.

1.3 The potential impact of IoB

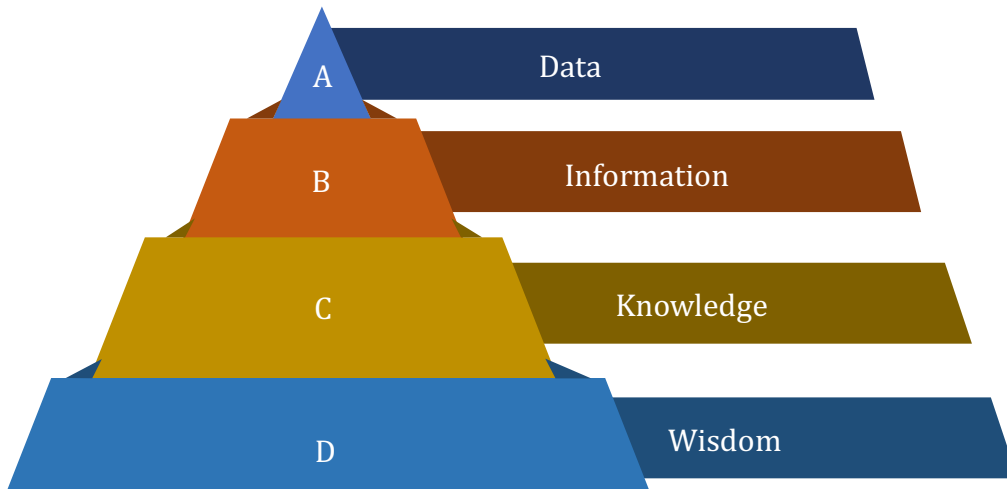


Figure 1: Pyramid of IoT and IoB in smart system.

The IoB idea makes an effort to accurately evaluate facts and use that comprehension to create and distribute new products from the perspective of human psychology. The IoB applies the insights of behavioural psychology to the study of collected data on online user habits. Using insights from human psychology, it attempts to find solutions to issues with the analysis of data and its application to the creation and provision of new services. With more companies considering upgrades to their connection in response to rising consumer demand, this new development might have an effect on the state of Infrastructure Facilities. Figure 2 depicts how the Internet of Things (IoT) transforms raw data into usable information, while the Internet of Things (IoT) may help us turn that information into true wisdom.



Figure 2: Mapping action of IoB and IoT.

2. Relationship between IoB and Explainable AI

Our civilization is becoming more algorithmic as AI is rapidly and widely deployed at the start of the fourth industrial revolution. In spite of everything that has been accomplished, trust in AI-based solutions is still hindered by a lack of openness. Incredible predictions may be made, but no explanations are provided. The debate about AI that can be explained has been rekindled (XAI). The trust and openness of AI-based systems might be greatly improved by a dedicated area for study. To make steady and unimpeded strides in AI, this is essential. The utilization of Intelligence for data mining is facilitated by explainable AI, which maintains transparency while using AI. It is for this reason that a new subfield of AI research, called 'XAI', has been developed: to translate AI results into language that humans can comprehend. Expert system explanations and the question of whether or not they should be explained have been the subject of research for decades. XAI has been variably characterised as the next wave of AI assistants that are easy for humans to understand and command while yet demonstrating impressive learning capabilities (prediction accuracy). Therefore, IoT helps gather necessary data, IoB helps understand student behaviours, and XAI helps anticipate student performance and identify the major factor(s) impacting such performance so that appropriate actions or suggestions may be made.

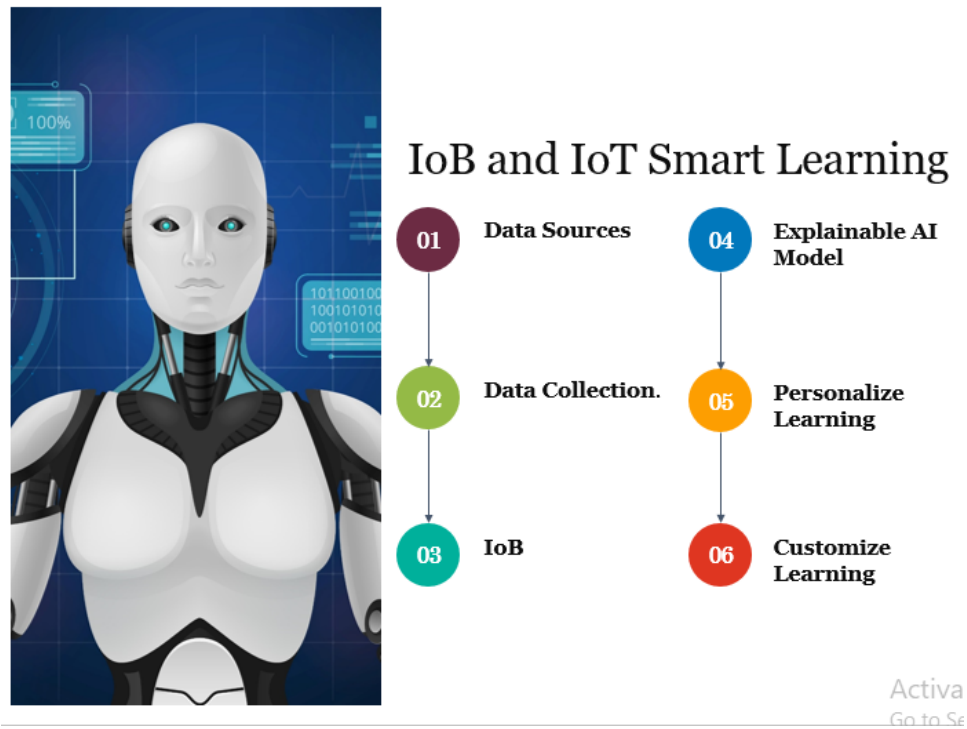


Figure 3: Framework of smart education.

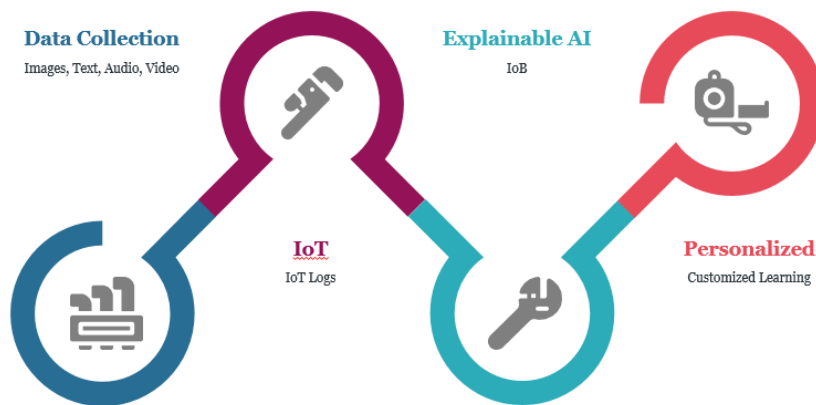


Figure 4: The steps of the proposed model.

3. Proposed Model

Our goal in using IoT was to gather information on student habits in two key domains: self-directed learning and social skills. We paid special attention to their verbal and written communication skills under "Personal Capabilities," and their propensity for teamwork and selflessness under "Social Keen." The acquired data is then utilised to determine learner behaviour patterns that account for the ML predictions, in particular the differences in predictions made for high, medium, and poor

performers across the two key capacities. Figures 3 and 4 demonstrate the importance of XAI in establishing a connection between student behaviour and capacity performance, which is necessary for making recommendations and tailoring learning material to different kinds of students.

123 students (students in programming courses) use Nearpods and the E - learning System Management (BBL) to conduct polls and other activities to determine whether or not the system supports such tasks. The use of mobile devices to facilitate student-to-student collaboration and game-based/formative assessments. Also, students were asked to fill out a questionnaire on the time they spent volunteering, the results of which are shown in the table following. Table 1 shows students' academic achievement and their social interests, broken down into four groups: speaking vs. collaborating vs. volunteering vs. writing vs. collaborating vs. volunteering vs. speaking.

We looked further to make sense of these students' actions. The primary goal is to evaluate the system's ability to understand student behaviour and tailor lessons to each learner's unique set of skills, interests, and background knowledge.

Table 1: Cognitive ability to learn and signs of social keens

		Personal Abilities				
		Speaking			Writing	
		Confusing professor	You seldom ever inquire	Explanatory Sentence	Habits of using short phrases	
Social Keen	Collaboration	Direction the effort	45	27	26	21
		Quietness	78	96	84	102
	Volunteering	Participation of God in Earthly Affairs	33	39	42	24
		Just pay attention to what you're supposed to do	90	84	81	99

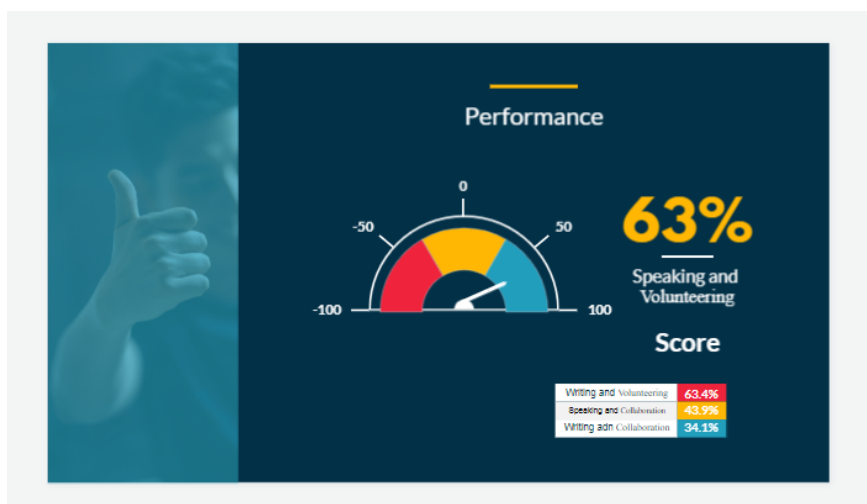


Figure 5: Performance of the smart learning.

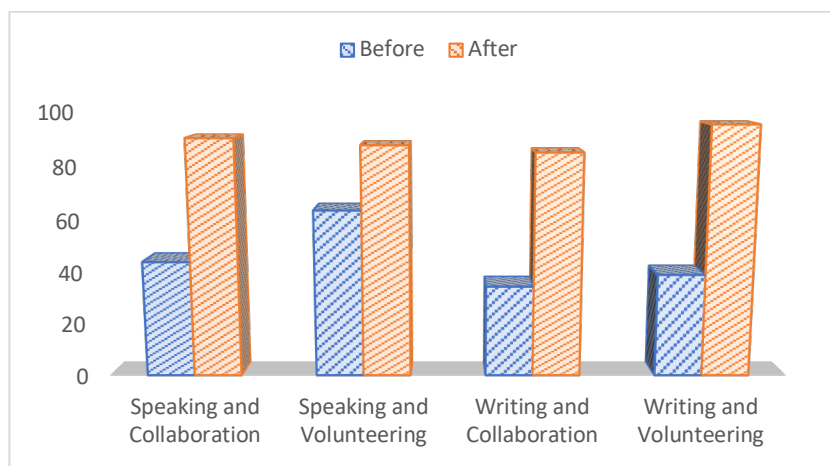


Figure 6: Alteration in Student Performance.

There was a greater increase (+56%) in students' independent writing tasks when the system tracked these tasks compared to the 50% increase in students' group writing tasks. Figure 9 shows that the number of cooperative endeavours rose by 46.3% while the number of volunteer speeches improved by 24.23%.

4. Discussion

In order to better understand how students' behaviours affect their academic performance, educational institutions may use IoT. The teaching method will help them make up for their shortcoming. In the first phase of the study, we assess the system's efficiency based on how it motivates students to engage in a variety of activities without alerting them to it and how student responses to academic assignments are affected by teacher monitoring through technology. Learners achieved the following results: SP = 43.9% (Speaking vs. Collaboration), SP = 63.4% (Speaking vs. Volunteering), SP = 34.5% (Writing vs. Collaboration), and SP = 39.0% (Writing vs. Volunteering). Since the primary goal is to use IoB to personalise learning materials and XAI to explain why so system acts in a given manner, the system should support related academic activities by classifying students into appropriate groups and selecting appropriate evaluation metrics. Personal Capabilities, which includes Speaking (difficult teacher, few questions asked), Writing, and Reading, were introduced to the students in Round 2. (Sentence with elaboration, Short sentences habits). Volunteering and working together (taking charge, keeping quiet) are great examples of social abilities (Heavenly involved in activities, Focusing on the given task). Students who were found to be asking few questions and to have difficulty expressing themselves in writing were given suggestions on how to strengthen their descriptive writing skills; similarly, students who were observed to be quiet but otherwise focused were given guidance on how to increase their level of elaboration. Specifically, the adjusted accordingly SP (Speaking vs. Cooperation) 90.23%, SP (Speaking vs. Volunteer work) 87.63%, SP (Writing vs. Collaboration) 84.93%, SP (Writing vs. Volunteer work) 95.2% led to an overall betterment in the system's functionality to assist learning by tailoring content to their needs by 63.79%. This demonstrates that we can aid students in making prudent academic decisions by designing a bespoke, controlled system for education in which they may determine which factors impact their achievement.

5. Conclusion

The Internet of Things is great for collecting data concerning students, whilst the Internet of Things in the Classroom is used to study how students respond to various classroom activities. The research found that low-achieving students tended to be reserved, focused on the job at hand, asked few questions, and preferred to write in brief sentences. Clearly, this is something that can be managed by including more resources into learning management systems with the express purpose of enhancing these skills. On the contrary hand, high-achieving learners are more likely to be assigned

challenging tasks by their teachers, to elaborate in their writing, to take the initiative during class, and to enthusiastically engage in extracurricular events (SVH). Each student's actions may be recorded in a unique profile, which can then be used by the school to provide suggestions on how the student might improve in certain areas and even give them practice problems to work on at home.

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