

Research Article

A PEDAGOGICAL PERSPECTIVE ON IOT AND AI INTEGRATION IN SOCIAL SCIENCE TEACHING

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ABSTRACT

A surge of technological advancement observed in every sector including education. The Internet of Things (IoT) is one of the groundbreaking technology are being used in education sector also but it is limited to education management, education administration. After an in-depth literature review it is unveil that the IoT technology is not used in direct arts pedagogy and there is a need of instructional framework to intervene IoT technology to teach arts subject. This study focused on development of an instructional model to integrate IoT technology to teach Social Science at middle school. The study was carried out with descriptive mixed method approach to develop the model. A stratified purposive sampling method was used to select schools and students to understand existing technology use in schools. The CBSE (Central Board of Secondary Education) board standard VIII was considered for the study. From the Social Science textbook under CBSE curriculum, some chapters were nominated for the IoT and AI technology intervention. The model was validated by subject experts. The findings of the study reveals that students were aware of various advanced technology but they didn't use IoT in their classroom, teachers wanted to learn and use this technology in Social Science teaching, among three books of Social Science subject seven chapters were considered for the study, and experts gave positive rating regarding validation of the newly developed model.

INTRODUCTION

The world is experiencing an agile technological advancement. The Internet of Things (IoT) technology introduced by Kevin Ashton at Britain in 1999 which is one of the pioneer technologies. As per a projection India set to reach US\$26.93bn revenue by IoT market (Statista, 2025). India integrating IoT technology in various sectors including industry, agriculture, smart city, healthcare (Yadav & Sumant, 2023). A very little facts found regarding IoT application in education sector in India. IoT technology commonly using in education management, administration, and for security purpose in campus. Throughout the world this advanced technology is being used in education sector in updated version. In October 2022, Intel collaborated with Central Board of Secondary Education to integrate IoT in school curriculum. National Policy of Education 2020 focused on contemporary technology intervention in education to make learning more experiential, collaborative and personalized. This paper focused on development of an instructional model to integrate IoT and AI for specifically arts subject like Social Science.

RELATED LITERATURE REVIEW

Theoretical Framework

“Experiential Learning: experience as the source of learning and development” a book by Kolb (1984) explained how ideas or thoughts are dynamic in nature as experience add on and turn this a continuous process. His learning cycle has four stages: Concrete Experience (A student using IoT device to understand classroom humidity), Reflective Observation (Student express if this device is interesting or any problem faced), Abstract Conceptualization (Student form ideas or concepts behind they experienced), and Active Experimentation (Student able to frame a new digital project). Learning occurs in flow with experience add on.

“The Technological Pedagogical Content Knowledge Framework for Teachers and Teacher Educators” presented by Koehler et al., (2013) showed how TPACK framework works to integrate technology in teaching. They considered the technology should be context-bound as per need of learner and subject matter. TPACK provides conceptual framework not a procedural sequence of classroom practices in terms of technology integration.

International Studies on IoT

Using PRISMA methodology 60 selected journal and conference articles studied by (Abhichandani et al., 2022) related with IoT implementation in K-12 curriculum. The research reveals that Arduino, Raspberry Pi these physical computing devices were used to form educational IoT kit. As well as to assess learner’s knowledge, skills IoT technology can be used.

(AYDIN & GOKTAS, 2023) examined the effects of physical variables in classrooms on students’ attention via the Internet of Things. They used Arduino Uno R3 card, Grove module, Grove sensors (temperature, humidity, air quality, light, and sound and found temperature had an impact on the attention and motivation of students.

“Usage of IoT in the Higher Education Sector” a study conducted by Saeed et al., 2021 to

identify the use of IoT in physical spaces like classroom, to track teaching activities, e-learning contribution, to analyze the assessment of IoT implementation in higher education institutions. They identified that IoT technology can be considered to monitor teaching activity, e-learning and also useful to improve education quality of higher education institution. The study revealed some infrastructure, security and privacy related challenges in terms of IoT implementation in higher education.

“The Critical Application of IoT in the overall Development of Education” by Chahal, 2023, studied on application of IoT in personalized learning and how IoT can be used by teachers to monitor students mental state and stress levels through wearable bands which will track students heart rate. The researcher also focused on resource management using IoT technology.

National Studies on IoT

To enhance innovative mind of young generation and to boost up learning outcome of learners between standard VI to X, a programme launched named “Integrating AI and Tinkering with Pedagogy (AIoT) in collaboration with Atal Innovation Mission – NITI Aayog. The programme provided 70 lesson plans integrating IoT technology from CBSE board curriculum.

Studies on Technology in Social Science Teaching

Erdogan & Serefli (2021) examined personal experiences of five social science teachers through narrative research method and they found that those teachers faced limited access of technology in social science teaching. The reasons behind these limited opportunities in rural schools and primary section specifically.

A constituent unit of NCERT (National Council of Educational Research and Training), CIET (Central Institute of Educational Technology) conducted an online training program on November, 2025 to empower Social Science teachers with advance technologies that aligns with the vision of National Education Policy 2020. The program included design dynamic and accessible learning resources, create visual narratives for the classroom, leverage data for insightful classroom discussion, and build a unified digital learning environment.

Research Gap

Mostly a lot of research work initiate on IoT application in education such as – i. in student monitoring, ii. to monitor teaching activity, iii. in e-learning, iv. to improve overall higher education quality, v. to monitor learners mental state and stress level, vi. to manage resources in school campus.

A prominent lacking is evident that there is no instructional model to integrate IoT technology in school curriculum. Specifically a lacuna identified to teach arts subject like Social Science using IoT technology. This study focused on development of IoT-based instructional model to teach Social Science at school level. Equally application of IoT in arts subject is a treasure that can be explored.

Research Objectives

A rigorous literature review and identified study gap leads to frame objectives of the study.

These are-

- i. To explore the technology that are being used in the classroom.
- ii. To scrutinize opinion of teachers regarding the IoT technology integration
- iii. To plan appropriate IoT devices with relevant chapters for instructional alignment.
- iv. To validate the IoT-based instructional model through expert evaluation.

Research Questions

In search of appropriate instructional design to effective intervention of IoT technology in Social Science teaching need to understand both teacher and learner's readiness and in which chapter or topic would be suitable for IoT intervention, these research question framed by the researchers-

RQ1: What are the existing technologies are being used in schools?

RQ2: What are the opinion of teachers to integrate IoT technology?

RQ3: Which IoT devices are best-fitted according to chapter?

RQ4: How do expert evaluation support the validity of the AIoTSST model?

METHODS

Study Design

Descriptive mixed method research design was adopted by the researcher to deal with the research questions. It is necessary to know which technology are being used at present in classroom to teach Social Science and to check the opinion of teacher in terms of new technology introduction. Descriptive research method will generate appropriate existing situation. The collected data analyzed using both quantitative and qualitative approaches.

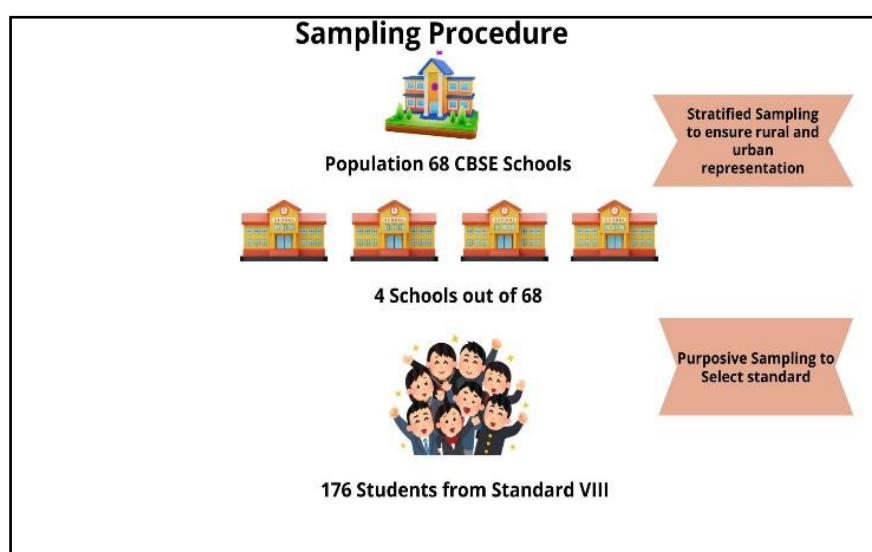


Figure 1: Stratified Purposive Sampling

Participants and Setting

For the study four CBSE (Central Board of Secondary Education) board schools were selected using stratified purposive sampling technique to ensure representative from both rural and urban schools. The schools were classified in strata based on location of school. The study focused on instructional model development for middle school level, hence voluntarily the researcher selects standard VIII for this study.

Data Collection Tool

In this study four data collection tools were used that were researcher-made and validated by experts.

- I. Classroom Technology Utilization Inventory (CTUI)
- II. Teachers' Perception on IoT Technology (TPIT)
- III. Chapter Selection Rating Scale (CSRS)
- IV. Instructional Model Expert Review Tool (IMERT)

Data Collection Procedure

1. The researcher prepared draft of questionnaire to get an image of existing technology use in classroom. The questionnaire draft evaluated and validated by Education Technology background experts and finally 19 questions were there in the 'Classroom Technology Utilization Inventory' (CTUI) tool includes Multiple Choice Questions, Yes/No types questions, Rating Scales, Agree/Disagree type questions. The questionnaire was distributed to 179 standard VIII students of 4 CBSE board English Medium schools.
2. Likewise, the CTUI tool the researcher prepared opinionnaire for teachers named 'Teachers' Perception on IoT Technology' (TPIT) to understand their opinion regarding the IoT technology integration in classroom instruction. The opinionnaire draft was evaluated and finalize after expert evaluation. The opinionnaire includes total 26 questions covering Yes/No, Rating Scale, Agree/Disagree, and Open-End type questions. The questions from various aspects like: technology use, technology proficiency, impact of technology in learning, readiness to use advance technology, privacy and ethics related to technology use, AI in education. The opinionnaire was provided to 87 teachers from four CBSE board schools.
3. The study focused on IoT and AI technology integration especially in Social Science teaching. The researcher set some parameters in front of experts using Chapter Selection Rating Scale (CSRS) to select chapters from Social Science textbook of standard VIII, these are – relevance to IoT applications, real-world connection, demonstration with AI, visualization using AI, hands-on experimentation.
4. From Information and Communication Technology background experts the developed model was evaluated and validated with the help of Instructional Model Expert Review Tool (IMERT) tool.

Data Analysis

Technology Selection

The researchers selected the Arduino IDE (Integrated Development Environment) software application for this study as the software is user friendly in nature. From Udemy “Arduino for Beginners- 2023” course delivered by Edouard Renard completed by the researchers to understand the use of this software well. After comparing three microcontroller like Esp-32, Esp-8266, and Arduino-Uno, the researchers selected esp-32 microcontroller for this research.

Table 1: Microcontroller Selection

<i>Feature</i>	Esp-32	Esp-8266	Arduino-Uno
<i>S-RAM</i>	520 KB	80 KB	2KB
<i>GPIO pins</i>	34	17	14
<i>Bluetooth</i>	Yes	No	No
<i>WiFi</i>	Yes	Yes	No
<i>Power Consumption</i>	Low 10 micro-Amp	Moderate 20 Micro Amp	High 50 mili Amp
<i>Flash storage</i>	4MB	4MB	32KB
<i>CPU</i>	Dual-core Xtensa LX6 (160-240 MHz)	Single-core Tensilica LX106 (80 MHz)	ATmega328P (16 MHz)

Social Science subject includes three textbooks named Resources and Development (Geography), Social and Political Life –III (Civics), and Our Past – III (History). Using CSRS tool the researcher finalizes nine chapters from these three textbooks for the IoT and AI integration in Social Science subject.

Table 2: Technology and Chapter selection

Sr. No.	IoT/AI	Topic	Chapter Name	Textbook
1	Solar Sensor	Solar Energy	Resources	Resources and Development
2	Soil moisture sensor	Soil	Land, Soil, Water, Natural Vegetation and Wildlife Resources	Resources and Development
3	Turbidity sensor	Water	Land, Soil, Water, Natural Vegetation and Wildlife	Resources and Development

4	Vibration sensor	Landslide	Resources Land, Soil, Water, Natural Vegetation and Wildlife Resources	Resources and Development
5	DHT11, Soil moisture sensor	Agriculture	Agriculture	Resources and Development
6	Push button	Mock parliament	Parliament and the Making Laws	Social and Political Life - III
7	TDS	Public facilities	Public Facilities	Social and Political Life – III
8	AI	From Trade to Territory	From Trade to Territory	Our Pasts - III
9	AI	Civilising the 'Native', Educating the Nation	Civilising the 'Native', Educating the Nation	Our Pasts - III

Model Development

The entire study was theoretically grounded on Kolb's experiential theory. After selection of appropriate IoT and AI technologies the researcher developed the instructional model. There are six steps in the 'Artificial Intelligence Internet of Things Social Science Teaching' (AloTSST) model starts from specify learning objectives, step two analyze need of target population, step three need to select content specific technology, step four develop content by integrating technology, step five test the newly developed content in small scale, step six analyze the feedback of pilot testing and finalize the content.

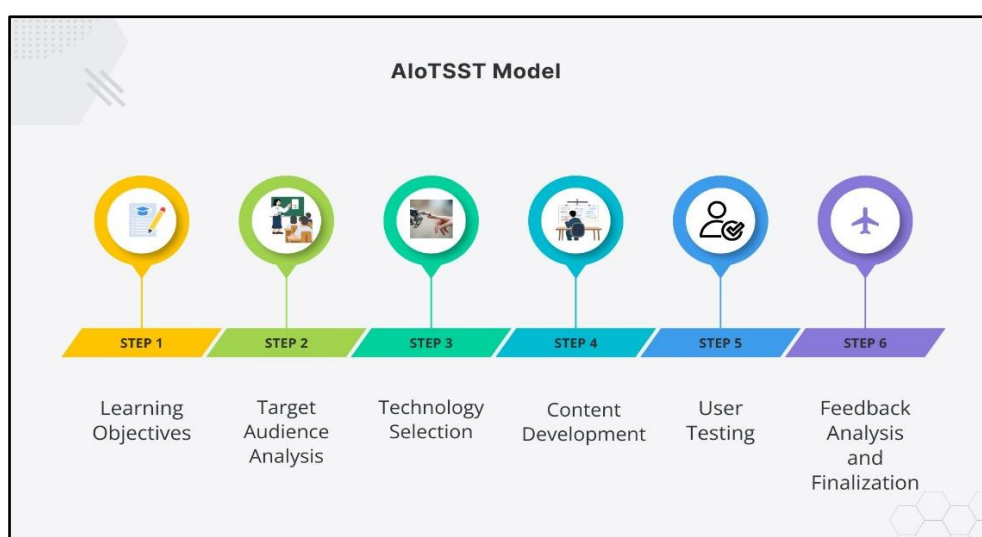


Figure 2: AloTSST Model

RESULT & DISCUSSION

The CTUI tool reveals the technology that are being used in standard VIII classroom, these are – computer, projector, ChatGPT, digital board, CCTV camera, Alexa, digital ID card, etc. said by students. The data was collected from total 176 students and among them 161 students given their responses. The values displayed in each bar represents the frequency of responses given by students.

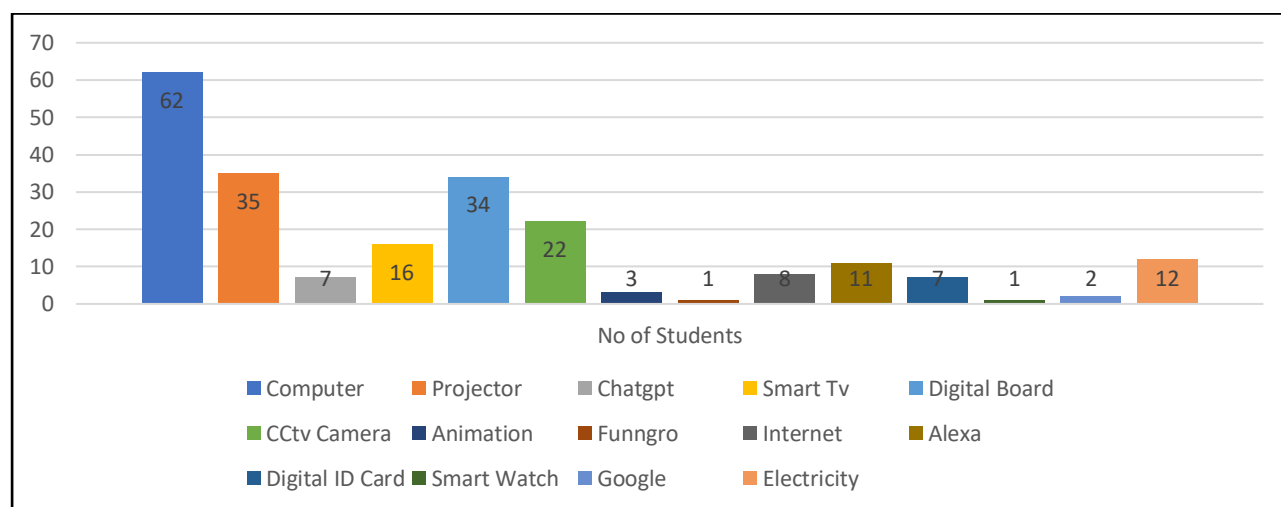


Figure 3: Existing Technology Use in Classroom

The TPIT tools provide the opinion of teachers regarding the IoT and AI technology integration. They majorly agreed with that the IoT technology has the ability to enhance students' future employability, this new era technology makes learning easy, promotes divergent thinking. Among 87 teachers 61 teachers given their feedback.

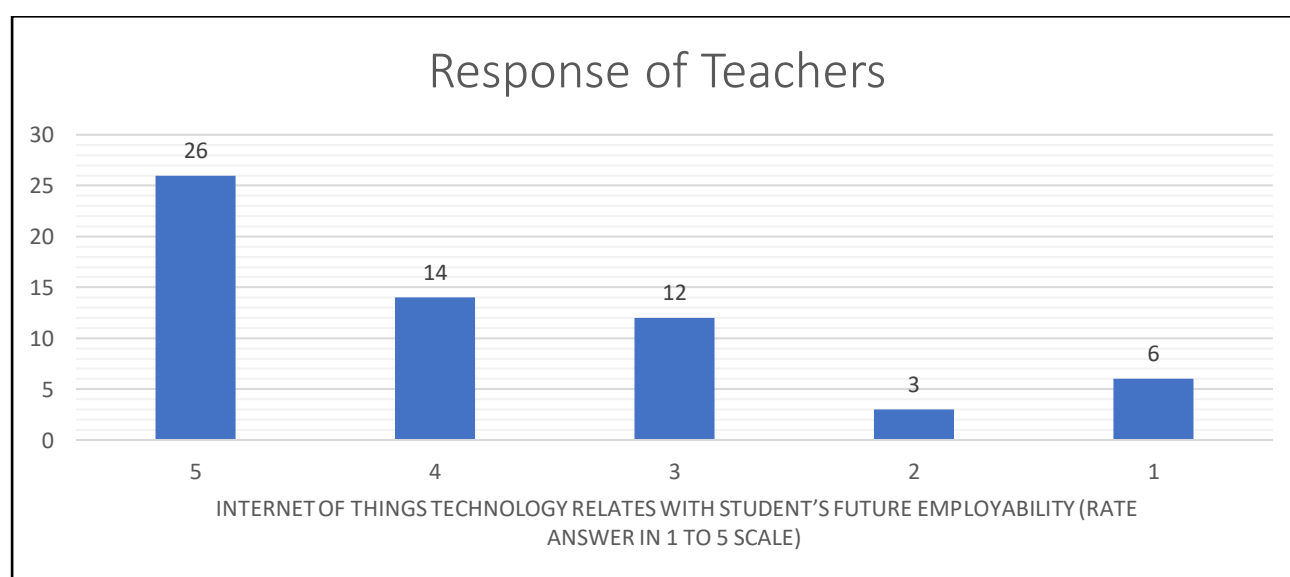


Figure 4: Teachers' Opinion for Technology Integration

The Esp-32 Microcontroller, Arduino IDE software, and various sensors were selected for the study. To collect real-time data some command was used in Esp-32 like: *dht.readHumidity()* for humidity detection, *dht.readTemperature()* to detect temperature, *analogRead(solarpin)* for solar sensor, *analogRead(tdsSensorPin)* to check TDS value, *analogRead(soilmoist)* to check soil moisture, *digitalRead(vibration Pin)* for earthquake detection, *digitalRead()* for pushbutton in election. These IoT devices were considered for Social Science subject instruction in classroom at standard VIII.

The AIoTSST model was validated by five experts as they have given their feedback on the model through Instructional Model Expert Review Tool (IMERT) and after reviewing the model was refined and finalized by the researcher. The evaluation parameters were: the model how much aligned with the CBSE prescribed Social Science curriculum, to what extent the model can be applied in school infrastructure, student engagement capacity of the model, to what extent the model influence learning outcome, how strongly the experts recommend the model for implementation?

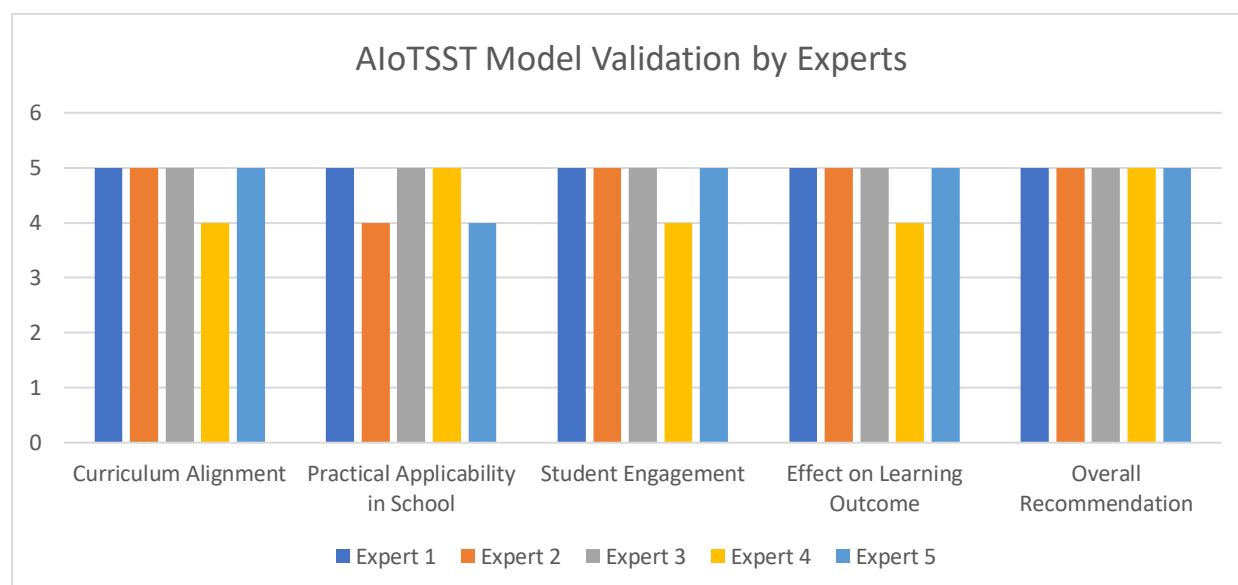


Figure 5: Model Validation

CONCLUSION

The study aimed to develop and validate a systematic instructional model for Social Science subject by integrating the IoT and AI technology at standard VIII. The findings revealed the students aware of advanced technology but no direct use of IoT in Social Science pedagogy is observed, teachers found ability of IoT technology to enhance future employability of students. The study further identified feasible IoT devices and AI technology aligned with curricular chapters from Social Science subject. The experts were agreed that the AIoTSST model has the ability to cover most of the chapters of Social Science at standard VIII, feasible to align with curriculum, has ability to enhance student engagement, has the potential to increase learning outcome.

Overall, the study offers AIoTSST instructional model for Social Science teaching by

integrating IoT and AI technology which are well aligned with curriculum and validated by experts. The future research may focus on implementation of the AIO TSST model in large-scale across diverse educational setting.

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