Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 3, Issue 6, 2025

IOT EFFECTIVENESS IN SUPPORTING ACADEMIC WORK AND ENHANCING LEARNING EXPERIENCES

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DOI: https://doi.org/10.5281/zenodo.15680111

Keywords
Internet of Things; IoT in Education; IoT effectiveness in education; students' perception of IoT; Task Technology Fit

Article History
Received on 08 May 2025
Accepted on 08 June 2025
Published on 17 June 2025

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Abstract
This paper aims to examine students' perceptions concerning the effectiveness of IoT in the form of academic work support from the use of IoT tools and the improvement of learning in the context of higher education. A cross-sectional research approach was employed and quantitative data were gathered using a structured questionnaire administered among undergraduate students at the University of Sindh, Jamshoro, Pakistan. The questionnaire measured dimensions such as characteristics of the task, characteristics of the technology, task-technology fit, and the effect of the technology on performance. Descriptive statistics were used to analyze data. The results showed students generally perceive that the use of IoT facilitates education tasks efficiently, such as real-time access to information, enhancing classroom interactions, and the ability to deliver personalized studies. Concern with data protection, technical issues, and unreliable access to IoT facilities across institutions was also noted. In connection with the findings, the study recommends strategic alignment of IoT with academic tasks, investment in digital infrastructure, and capacity building through awareness and training for effective and secure adoption in higher education.

INTRODUCTION

The Internet of Things (IoT) is a system of things (physical objects) with special software, sensors, and other technologies interconnected via the Internet in order to gather and share data. In educational contexts, IoT is meant for the inclusion of intelligent devices and sensors in educational environments in order to upgrade the learning experience as well as the efficiency of operations.

IoT technology is increasingly being applied in different fields like education. It can redefine higher educational institutions through innovative solutions for teaching, learning, as well as campus administration [1].

Research Objective

To explore the perception of higher education students regarding the effectiveness of IoT technologies in supporting academic tasks and enhancing learning experiences.

Justification & Significance of the Study

IoT technologies are probable to augment and enhance education in many aspects. The most popular applications of IoT in education are IoT-integrated classrooms and smart classrooms. IoT devices including sensors, interactive display units, and wearable technologies significantly improve teaching and learning experiences.

Besides the increasing use of IoT in education including higher education, the literature lacks studies that examine how well IoT supports the academic tasks performed by students and teachers. Utilizing the Task-Technology Fit framework this study aims to examine how effectively IoT technologies fit with the academic needs, and how this alignment affects students' performance.

LITERATURE REVIEW

IoT Applications in Education

Smartly designing the learning space is an effective solution to bridging the gap between conventional learning systems and modern educational needs [2]. Technologies with the greatest impact are those that are such integral parts of our daily lives, as they become intangibly invisible

[3] The essential advantages of IoT devices and applications on learning are:

- **Remote Teaching**

Using cutting-edge remote learning solutions, teachers can hold online sessions facilitated by IoT. Remote classes through the use of the Internet and technologies, educators were able to hold virtual classes, webinars, as well as digital lectures. Tools for video conferencing like Zoom, Microsoft Teams, and Google Meet became essential tools for face-to-face interaction between teachers and students. Remote teaching using IoT enables online lecture delivery, online attendance, and online examinations [4].

- **Smart Classes**

Smart classrooms the sophisticated conceptual learning platforms would record, keep track of, and recognize the progress, attendance, and any other information about the students [4]. Often enough, smart classrooms use AR/VR headsets and smart boards to make teaching sessions interesting as well as easy to understand.

- **Personalized Education**

IoT sensors and IoT devices can be utilized by teachers to produce courses that are made according to the needs of every student[5]. AI employs its intelligent teaching capacity to adjust the pace of instruction as well as what is taught in a curriculum based on how students are absorbing the content. IoT solutions can also help teachers refine their teaching abilities so they better understand what does and does not work in the classroom.

- **Managing large Quantities of Data**

The Internet of Things allows universities and schools to operate large quantities of data with the help of an interconnected system of intelligent devices. Numerous opportunities are made available through this, like handling professional development for teachers, measuring student progress, and monitoring security procedures [6].

- **Improved management**

Aside from teaching students, educational institutions have to manage the dispensing of cash, provision of supplies, and processing of important documents Incorporating IoT solutions creates the foundation for accelerated, efficient, and foul-proof working and decision-making [6].

Challenges and Considerations

There are some challenges associated with the integration of IoT integration in educational settings. For a successful adoption, these challenges need to be tackled.

The biggest challenge is the proper use of the technology by the teachers and the students, which requires faculty training to effectively use and guide students appropriately.

Another major challenge is the concern for the privacy and security of user information [6]. To tackle this, clear policies to ensure the protection of user data and usage information need to be framed and applied.

RESEARCH METHODOLOGY

Research Design

The current study used a quantitative cross-sectional research design to examine IoT effectiveness in higher education.

Population of the Study

Table 1 Population of the Study

Study Level	Enrolled Students	Percentage of Enrollment
Undergraduate	33616	86%
Post Graduate	5473	14%
Total	39089	100%

The statistics show that the selected university for the study has a total of 39089 students enrolled, among them a clear majority of 33616 (86.%) are enrolled in undergraduate programs. These statistics suggest that focusing on undergraduate students at the University of Sindh to investigate the effectiveness of IoT in education is relevant as it represents the leading academic level at the selected university.

Sampling Technique and Sample Size

A sample is a subset of a large population, which has the characteristics of the population and represents its diversity in a study [7]. The findings from the representative sample are generalized to the entire population [8]. A specific sampling technique that aligns with the research design and aims to be applied to select the sample. Further, the sample size to be statistically finalized to have enough sample size to represent the population and gain valid, and reliable outcomes [9].

Employing a convenience sampling method, the entire classes of undergraduate students from several disciplines were selected to form the sample of the study.

Table 2 Sample of the Study

Study Level	Total No. of Students	Sample of the Study
Undergraduate	33616	380

Using the standard sampling technique, a representative sample of 380 undergraduate students of the University of Sindh, Jamshoro were selected to participate in the study.

Data Collection Procedures

The data was collected using a self-administered questionnaire that included close-ended Likert scale items and open-ended questions. The questionnaire consisted of questions to gather students' perceptions on the effectiveness of IoT in fulfilling their academic needs to improve their academic performance.

Data Analysis Techniques

The collected data were analyzed using descriptive analysis to summarize the responses and identify key patterns, trends, and insights related to students' experiences with IoT applications in higher education.

Ethical Considerations

The study followed the ethical guidelines for research [10], [11]. Before data collection, the participants were informed about the aim and purpose of the study, and their consent was obtained. Throughout the study, the confidentiality and anonymity of the participants were ensured.

RESULTS AND DISCUSSION

Demographics of the Respondents

This study aimed to investigate the effectiveness of IoT technologies in higher education in Pakistan and was conducted with 380 undergraduate students of the University of Sindh, Jamshoro Pakistan.

Table 3 Demographics Statistics of the Respondents

Category	Sub-Category	Frequency	Percent
Gender	Male	120	60.91
	Female	77	39.09

	Total	**197**	**100.00%**
Discipline	Computer Science	40	20.30
	Mathematics	31	15.74
	Information Technology	30	15.23
	Zoology	29	14.72
	Statistics	22	11.17
	History	15	7.61
	Management Science	14	7.11
	English	9	4.57
	Geology	5	2.54
	Biochemistry	2	1.02
	Total	**197**	**100.00%**
Academic Year	First Year	80	40.61%
	Second year	48	24.37%
	Third year	40	20.30%
	Fourth-year	29	14.72%
	Total	**197**	**100.00%**

The demographic statistics provide a meaningful context to interpret the results of the study on the effectiveness of the IoT in higher education.

The gender-based insights show that the sample was well dominated by males at 60.91% as compared to females at 39.09% only. This gender imbalance reflects the general enrollment trends at the university in particular or could be because of the greater male participation in technology-related studies or in research in general.

The discipline-based insights show that the respondents belonged to a wide range of academic disciplines. The highest representation was from the disciplines of Computer Science 20.30%, mathematics 15.74%, and IT 15.23%. These insights suggest that they had a strong technological background or strong interest in IoT applications.

The academic year-based insights show that the academic years from the first year to the fourth year were well represented in the study with the first year at 40.61%, the second year at 24.37%, the third year at 20.30%, and the fourth year at 14.72%. The most representation from first year students may be attributed to their increased availability, however, this also suggests that the students who have less exposure to university education are more influenced by IoT effectiveness.

Table 4 Internet Experience-Based Distribution of the Respondents

Internet Use Experience in years	Frequency	Percentage
1	1	0.51%
2	18	9.14%
3	43	21.83%
4	44	22.34%
5	28	14.21%
6	20	10.15%
7	15	7.61%
8	12	6.09%
9	10	5.08%
10	1	0.51%
11	3	1.52%

12	2	1.02%
Total	**197**	**100.00%**

The insights show that the respondents had different internet use experiences ranging from 1 to 12 years. The highest representation had internet use experience of 4 years, 22.34%, 3 years 21.83%, and 5 years 14.21%, they collectively account for 58.38%.
These insights suggest that the responding learners are familiar with the Internet due to their regular general, social, and academic use. The Internet use experience positively influences their IoT use in education.

Descriptive Analysis

Descriptive analysis provides a means of summarizing and arranging data to make it easier to comprehend. It allows researchers to describe what the data indicates. Descriptive analysis provides a clear picture of the data collected. It facilitates easier identification of patterns or trends [12], [13]. Descriptive analysis allows teachers, administrators, and policymakers to make informed decisions based on findings.

Table 5 Descriptive Statistics of Items

Item	Mean	SD
TASK1 – I need to manage my lectures anytime anywhere	4.99	1.70
TASK2 – I don't need to miss my lectures.	4.91	1.72
TASK3 – I need to have real-time control over my assignments	4.93	1.72
TASK4 – I need to learn interactively.	4.99	1.71
TECH1 –IoT provides ubiquitous services	4.94	1.81
TECH2 –IoT provides real-time services	4.94	1.71
TECH3 –IoT provides a quick service	4.64	1.71
TECH4 –IoT provides secure services	4.76	1.88
TTF1 –IoT lecture delivery services are appropriate	4.82	1.70
TTF2 –IoT attendance management services are appropriate	4.73	1.81
TTF3 –Real-time IoT services are appropriate	4.65	1.79
TTF4 – I can get lectures quickly and easily when I need them.	4.75	1.67
USAGE1 –I use IoT regularly	4.67	1.70
USAGE2 –I use IoT to manage my lectures and notes	4.81	1.84
USAGE3 –I use IoT to make assignments	4.78	1.82
PI1 –I gain time using IoT	4.91	1.88
PI2 –IoT in classrooms allows me to concentrate more on my lectures without any distractions.	4.89	1.74

The descriptive analysis statistics show that the participants generally hold positive perceptions across various aspects of IoT effectiveness in education. The mean scores ranged from 4.64. to 4.99 suggest a high level of agreement with the statements related to task characteristics, technology characteristics, task-technology fit, usage, and performance impact. Further, the standard deviation scores ranging from 1.67 to 1.88, reflect that the respondents mostly share similar opinions on IoT effectiveness in education in supporting academic work and enhancing learning experiences.

The statistics in the task characteristics domain indicate that the respondents strongly prefer flexibility, control, and interactivity in learning. They expect autonomy and active engagement in IoT education.
In the domain of technology characteristics, the insights indicate that the respondents positively perceive the technological capabilities of IoT to offer ubiquitous and real-time services. Their trust in IoT's technical capability supports its adoption education.
Under the task technology fit domain, the insights indicate that the responding students perceive a

balanced alignment between the academic tasks and IoT capabilities. This suggests IoT is appropriate for supporting students' educational needs.

The insights in the usage domain indicate that the learners are actively engaged with IoT in education this is indicative of learners' acknowledgment, and acceptance of IoT potential in education.

Further, the insights in the performance impact domain indicate that the learners see notable academic benefits of IoT applications in education.

CONCLUSION

This study examined student perception of IoT technologies' effectiveness in supporting academic tasks and enhancing learning experiences in higher education focusing on undergraduate students. The effectiveness of IoT was analyzed under the constructs of task characteristics, technology characteristics, task-technology fit, usage, and performance impact. The respondents reported positive experiences with IoT technologies acknowledging their potential to cater to students' needs. These findings are aligned with the global trends advocating IoT integration in the educational domain to enhance teaching and learning experiences.

Recommendations

Holistic integration: For better learning and effective use of resources, the administration and authorities in higher education should strategize the integration of IoT technologies in education. There should be an alignment between the designated educational tasks and the technologies.

Policymakers in higher education should frame policies to safeguard the security and privacy of users' information. Such ethical policies will inspire responsible IoT usage in the learning environment by ensuring the safe, and ethical adoption of the IoT technologies by educational institutions.

REFERENCES

[1] Z. M. Gaffas, "Students' perceptions of e-learning ESP course in virtual and blended learning modes," *Educ Inf Technol (Dordr)*, vol. 28, no. 8, pp. 10329–10358, 2023, doi: 10.1007/s10639-023-11579-x.

[2] A. Sadeghi-Niaraki, "Internet of Thing (IoT) review of review: Bibliometric overview since its foundation," *Future Generation Computer Systems*, vol. 143, pp. 361–377, 2023, doi: 10.1016/j.future.2023.01.016.

[3] L. M. Castro Benavides, J. A. Tamayo Arias, M. D. Arango Serna, J. W. Branch Bedoya, and D. Burgos, "Digital Transformation in Higher Education Institutions: A Systematic Literature Review," *Sensors (Basel)*, vol. 20, no. 11, 2020, doi: 10.3390/s20113291.

[4] I. A. Ghashim and M. Arshad, "Internet of Things (IoT)-Based Teaching and Learning: Modern Trends and Open Challenges," *Sustainability*, vol. 15, no. 21, p. 15656, Nov. 2023, doi: 10.3390/su152115656.

[5] Kostiantyn Oliynyk, "IoT in Education: A Game-Changer for Learning," WebbyLab. Accessed: Jun. 01, 2025. [Online]. Available: https://webbylab.com/blog/impact-of-iot-technology-on-education/

[6] "Implementing IoT In Education: Applications and Benefits," Cogniteq. Accessed: Jun. 02, 2025. [Online]. Available: https://www.cogniteq.com/blog/implementing-iot-education-benefits-challenges-use-cases

[7] T. Wang and E. C. K. Cheng, "Towards Effective Teacher Professional Development for STEM Education in Hong Kong K-12: A Case Study," *Lecture Notes on Data Engineering and Communications Technologies*, vol. 154, pp. 3–19, 2023, doi: 10.1007/978-981-19-8040-4_1.

[8] S. Xia, "Customer Satisfaction Integration Model of Mobile Communication Service Market Based on Data Mining," *IEEE International Conference on Knowledge Engineering and Communication Systems, ICKES 2022*, 2022, doi: 10.1109/ICKECS56523.2022.10059892.

[9] S. Mallik and A. Gangopadhyay, "Proactive and reactive engagement of artificial intelligence methods for education: a review," *Front Artif Intell*, vol. 6, 2023, doi: 10.3389/frai.2023.1151391.

[10] "Guidelines for Research Ethics in the Social Sciences and the Humanities," National Committee for Research Ethics in the Social Sciences and the Humanities. Accessed: Dec. 27, 2024. [Online]. Available: https://www.forskningsetikk.no/en/guidelines/social-sciences-and-humanities/guidelines-for-research-ethics-in-the-social-sciences-and-the-humanities/

[11] David B. Resnik, "What Is Ethics in Research & Why Is It Important?," National Institute of Environmental Health Sciences (NIEHS). Accessed: Nov. 25, 2024. [Online]. Available: https://www.niehs.nih.gov/research/resources/bioethics/whatis

[12] J. Ahmed, F. H. Chandio, and S. H. F. Naqvi, "AN INVESTIGATION INTO STUDENT PERCEPTIONS: THE GAMIFICATION OF E-LEARNING SYSTEMS," *Pakistan Journal of Educational Research*, vol. 6, no. 2, pp. 706–733, 2023.

[13] J. Ahmed, F. H. Chandio, and Y. A. Malkani, "Investigating User Acceptance of Blended Learning at University Level: A Cross-Sectional Study," *International Journal of Distance Education and E-Learning (IJDEEL)*, vol. 9, no. 1, pp. 47–65, Dec. 2023.