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An Empirical Study on "Enhancing Educational Delivery through Internet of Things in Higher Educational Institutions"

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Abstract: The Internet of Things which provides new potential for improved learning experiences, operational efficiency, and real-time insights into student performance, is revolutionizing education. The educational environment can be greatly improved because to this technology, which makes it easier for physical objects, sensors, and controllers to communicate with one another. This is especially true in developing nations like India. Where usage of IoT in education has advanced thanks to tools like tablets and smart boards, there is still potential for development of IoT-based applications in education where a study was done. This study intended to explore use of IoT in the HEIs and how it can make education more application-centric. Through a pilot survey strategy that involved creating structured questionnaires for 200 respondents and distributing them to institutions in Hyderabad, primary data was collected to find out how many institutions use IoT devices for education was the main objective. IoT enhances raising standards in education by FY 2025, the market value of the Indian educational system is anticipated to grow rapidly. To fully utilize the potential of IoT in education, the report emphasizes the need for additional research and development in this field.

Key words. IoT Applications, Challenges, Implications, Factors Influencing the Implementation

INTRODUCTION

The Internet of Things is a network that links people, machines, smart devices, and other objects to one another as well as to sensors, gadgets, and smart technologies. IoT enables unique object identification and communication from everywhere at any time by connecting everyday physical objects to recognizable addresses that provide intelligent services and a lot of data. The Internet of Things, in particular, has a significant influence on the education sector. The COVID-19 epidemic has improved the use of ICT in education, with institutions incorporating IoT into educational activities because of IoT devices' pervasiveness. Even while IoT is still in its early phases and has a long way to go before it becomes useful, these connections are fast growing and creating a network of networks. IoT has nevertheless attracted interest on a global scale and is expected to keep expanding in the future.It has become essential to use IoT in the educational sector, making education one area where it has significant promise. Merit nation is the first platform among the start-ups in India using IoT to improve education, including Vedantu and Byjus. People's lives could be made easier by IoT in both developed and poor nations and actively used in different spheres of our lives, including supporting chronic patients, smart grid, city and transportation, etc.By incorporating IoT into education, educational institutions will undergo a revolution that will change staff members, campuses, administration, teaching, and learning procedures. Many institutions have already switched to using technology like tablets and laptops in place of traditional teaching techniques since the IoThas unique characteristics that improve learning. Students can learn at their own pace and maintain a consistent experience between home and school thanks to this. IoT not only helps students but also teachers by streamlining the learning process and enabling them to gauge their students' progress and offer extra help when required. The idea of e-learning, which substitutes electronic gadgets and devices for traditional books and papers, is also strongly supported by IoT. Education sector has significantly transformed the student engagement in learning process.The way that education is given and absorbed has been revolutionized by e-learning. It gives pupils the freedom to study from any location. Learning has been simpler and easier as a result, particularly for pupils who struggle in particular subject areas. Students can better understand concepts thanks to e-learning techniques. The necessity to transport bulky books to college or university has also been replaced by e-learning. The weight on students' shoulders has been reduced by the availability of course materials and textbooks on electronic devices. E-learning is an environmentally friendly approach of education as a result of this also lowering the

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need for paper.In the last ten years, IoT in education has advanced remarkably. It has increased educational standards and is advantageous to both emerging and developed nations. IoT improves learning capacity and inspires pupils to learn. In many instances, IoT-based education is of higher calibre and is more technologically advanced than conventional classroom instruction. From kindergarten to colleges, IoT may be applied in every aspect of education. There are issues with IoT in education, such as some pupils not adopting it and a rise in e-waste and electricity use. Nevertheless, technology has produced a more effective and dynamic learning environment, and instructors may raise the standard of instruction by adopting it. The aim of thi research paper is to examine the Applications of IOT in higher educational institutions.

OBJECTIVES

- To analyze the implications of the use of IoT in HEI
- To explore the factors of IoT devices among UG and PG students
- To study the usage pattern of IoT devices among the student community at UG and PG level
- To investigate the adoption of IoT devices in learning among colleges in Hyderabad at UG and PG level.

REVIEW OF LITERATURE

The development of IoT in HEI'S is going to equip and leverage solutions for the pressing problems. Recent literature survey provides a gateway to IoT. The application of IoT institutions reviewed by Singh and Bhatnagar (2021), who concluded that it can enhance student engagement, learning outcomes, and institutional effectiveness.Issues for securing the privacy, a necessity for standardization, and technical competence needs which are some of the difficulties faced.

IoT was utilized to provide a smart campus system that could monitor and control energy consumption, parking, and security in a study by Ramadass et al. (2020). The technology, according to the authors, could lower energy expenditures dramatically and raise campus safety. The usage of IoT in educational contexts was examined by Wu et al. (2019), who identified potential applications like smart classrooms, individualized instruction, and campus administration. When deploying IoT solutions in colleges, the authors emphasized the significance of resolving security concerns.IoT was employed in a study by Masrom et al. (2021) to initiate a smart library system that could track book usage, monitor temperature and humidity levels, and more and automate certain tasks such as book borrowing and returning. The authors found that the system could improve the efficiency of library operations and enhance the overall user experience.

Thakur and Gupta (2021) in his review identified few advantages which includes greater institutional effectiveness, personalized learning, and increased student engagement. The writers also talked about the difficulties that come with putting IoT ideas into practice, like the demand for technical know-how and the hefty implementation costs.

RESEARCH METHODOLOGY

Data was gathered from undergraduate and graduate students at Hyderabad's St. Ann's College for Women. To guarantee proper representation from different educational strata, a stratified random sample was used. Information on IoT device usage and the degree to which the college is utilizing IoT applications was gathered using a structured questionnaire. 160 students, 100 from undergraduate and 60 from graduate programmes, answered the questionnaire. Utilizing the SPSS programme, statistical methods including exploratory factor analysis and the T-test were used to investigate the data. Two components make up the questionnaire. Part A focuses on the profiles of the respondents, including their economic strata, educational background, and field of study. The idea was to connect IoT device apps to the education they are seeking. ICT, an online portal, and facilities are the three topics covered in Part B. Some questions in this section use a 5-point Likert scale with the anchors strongly disagree (1) and strongly agree (5).

The analysis sheds light on the adoption and usage trends of IoT devices in the institution and the variables that affect students' use of IoT devices and applications. Using the research's findings, initiatives can be created to increase the adoption and use of IoT hardware and software in educational institutions.

RESULTS AND DISCUSSION

To determine whether a set of data is suitable for factor analysis, apply the Kaiser-Meyer-Oklin (KMO) and Bartlett's Test. Bartlett's Test of Sphericity reached statistical significance (approximately chi-square 1359.813, df 120, and Sig.000), indicating the data is suitable for conducting factor analysis. KMO value was 0.835, exceeding the recommended value of 0.70, which can be considered adequate (Kaiser and Rice, 1974).Principal Component Analysis (PCA) using the Varimax Rotation Method was performed on the 16 items. Kaiser Factor analysis makes use of normalization. It is recommended to remove the items with factor loadings under 0.50 (Hair et al., 1996). There are no items removed from the study because all of the items had factor loadings greater than 0.50. In light of the acceptance of all 16 items, PCA showed that these 16 items are organized into 3 components with Eigen values greater than 1. The overall variance is 62.281 percent. The proposed instrument's individual dimensions explained a total variance of more than 60%, indicating the approach was appropriate. The table below shows the findings of the principal component analysis.The information displays the findings of a factor analysis performed on a questionnaire. The 21 questions in the survey were designed to gauge how much an educational institution has benefited from ICT, online resources, and infrastructure. Three elements were identified as a result of the factor analysis: ICT, an online portal, and facilities. Each component has a group of parameters with high values, which means they are accurate indicators of that component.

Table: Factors Extraction Results of the Items in Questionnaire

Component 1: ICT	**Factor Loadings**	**Eigen Value**	**% variance**
Q10. Integrating ICT (Information Communication Technology) in education is important	.816	5.822	36.389
Q11. Technology has changes the way you communicate with your teachers	.881		
Q12. ICT enabled education is a good supplement to face-to-face communication	.686		
Q13. ICT can counter the shortcoming in traditional learning	.710		
Q14. ICT helped you to score better in your examination	.808		
Q15. ICT helped you to do higher studies and to search for jobs.	.809		
Q16. Has ICT changed the way you read books?	.783		
Q17. Has ICT changed the way you write your assignments?	.727		

Component 1(ICT)-has the highest eigenvalue of 5.822, and it explains 36.389% of the total variance. The items with the highest factor loadings areQ11, Q14 ,Q15 and Q16 **indicating that the impact of ICT on education is mainly related to changes in communication, access to information, and improved academic performance.**

Component 2: Online Portal	**Factor Loadings**	**Eigen Value**	**% variance**
Q18. Do you think these educational portals will help improve your knowledge/skill levels?	.762	2.546	15.911
Q19. Do you think the content available in educational portals covers every topic in a subject?	.710		

Q20. Do you think that the online portal's interface is user attractive?	.848		
Q21. Do you like to browse through content other than your core subjects in academics?	.824		

Component 2-(**Online Portal**) has an eigenvalue of 2.546, explaining 15.911% of the total variance. The items with the highest factor loadings are Q18, Q20, and Q21, **indicating that online portals are perceived as a good source of knowledge, with attractive user interfaces that encourage browsing.**

Component 3: Facilities	Factor Loadings	Eigen Value	% variance
Q6. Do you have access to computers in your institution?	.636	1.597	9.981
Q7. Do you have Wi-Fi access in your campus?	.658		
Q8. Do you get to access your college computers even after the lab hours?	.853		
Q9. Does your teacher use video and sound aids for teaching?	.719		
Total percentage of variance		62.281	

Component 3(**Facilities**) has an eigenvalue of 1.597, explaining 9.981% of the total variance. The items with the highest factor loadings are Q8 and Q9, **indicating that access to computers, Wi-Fi, and multimedia aids is essential for effective teaching and learning.**

Overall, the three components explain 62.281% of the total variance, indicating that they are good indicators of the impact of ICT, online portals, and facilities on education. The results suggest that these factors have a significant impact on the quality of education, and policymakers and educators need to pay attention to them while designing and implementing educational programs.

T-test

The T-test Statistical tool for this research study is employed to determine whether there is significant difference between two mean groups

T-Test: Educational Qualification with Factors:

Group Statistics					
	Q1. Educational Qualification	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Facilities	UG	121	2.5351	.72119	.06556
	PG	43	3.2035	.73447	.11201

Independent Samples Test			
		Facilities	
		Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F	.152	
	Sig.	.697	
t-test for Equality of	t	-5.195	-5.150

Means	df		162	72.723
	Sig. (2-tailed)		.000	.000
	Mean Difference		-.66836	-.66836
	Std. Error Difference		.12865	.12978
	95% Confidence Interval of the Difference	Lower	-.92242	-.92704
		Upper	-.41431	-.40969

- **If the "Equal Variance assumed" Sig value is more than 0.05 then we must select "Equal Variance assumed" column t-value and Sig value.**
- **If the "Equal Variance assumed" Sig value less than 0.05 then we must select "Equal Variance not assumed" column t-value and Sig value.**
- **Null Hypothesis: There is no significant difference between Education Qualification towards Computer Facilities.**
- **If the sig value is less than 0.05 then reject the null hypothesis and else accept the null hypothesis.**
- **The sig value is 0.000 so reject the null hypothesis.**

Conclusion: There is a significant difference between Education Qualification towards Computer Facilities.

ICT:

Group Statistics					
	Q1. Educational Qualification	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
ICT	UG	121	3.9576	.66821	.06075
	PG	43	4.3750	.55702	.08494

Independent Samples Test				
			ICT	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		.065	
	Sig.		.800	
t-test for Equality of Means	t		-3.666	-3.997
	df		162	87.897
	Sig. (2-tailed)		.000	.000
	Mean Difference		-.41736	-.41736
	Std. Error Difference		.11384	.10443
	95% Confidence Interval of the Difference	Lower	-.64217	-.62489
		Upper	-.19255	-.20982

Null Hypothesis: There is no significant difference between Education Qualification towards ICT.

If the sig value is less than 0.05 then reject the null hypothesis and else accept the null hypothesis.

The sig value is 0.000 so reject the null hypothesis.

Conclusion: There is a significant difference between Education Qualification towards ICT.

Online Portal:

Group Statistics					
	Q1. Educational Qualification	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Online Portal	UG	121	3.1054	.57983	.05271
	PG	43	3.4419	.58969	.08993

Independent Samples Test				
			Online Portal	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		.407	
	Sig.		.524	
t-test for Equality of Means	t		-3.254	-3.228
	df		162	72.811
	Sig. (2-tailed)		.001	.002
	Mean Difference		-.33649	-.33649
	Std. Error Difference		.10340	.10424
	95% Confidence Interval of the Difference	Lower	-.54067	-.54424
		Upper	-.13231	-.12874

Null Hypothesis: There is no significant difference between Education Qualification towards Online portal.
If the sig value is less than 0.05 then reject the null hypothesis and else accept the null hypothesis.
The sig value is 0.001 so reject the null hypothesis.
Conclusion: There is a significant difference between Education Qualification towards Online Portal.

CONCLUSION:

Delivering improved learning experiences, operational efficiency, and in-the-moment student performance analytics, the integration of IoT in education has the power to completely change the educational environment. IoT-based application implementation in education, particularly in developing countries like India, still has space for development.IoT has the ability to change education and make it more application-centric, according to a study on the extent and impact of IoT-based applications in educational settings. The report emphasizes the necessity for additional study and advancement in this field to fully realize IoT's promise in education. According to the analysis of the survey results from the UG and PG levels at St. Ann's College for Women, (ICT) has the highest eigenvalue of 5.822 and accounts for 36.389% of the total variance. Demonstrating that improvements in communication, availability to information, and enhanced academic performance are the key effects of ICT on education. It is implied that students are benefited by IoT applications at the UG and PG levels. Online portals have an eigenvalue of 2.546, which the study also reveals, and which accounts for 15.911% of the overall variance. This finding suggests that online portals are regarded as reliable sources of knowledge because they have appealing user interfaces that stimulate surfing. The study also shows that access to computers, Wi-Fi, and multimedia tools is necessary for efficient teaching and learning, with an eigenvalue of 1.597 for ICT Facilities, which accounts for 9.981% of the total variance. The use of IoT devices and education were found to be significantly related. The three factors together account for 62.281% of the total variation, which shows that they are reliable predictors of how ICT, online portals, and facilities affect education. The

findings imply that these variables have a considerable impact on educational quality, and policymakers and educators should take these variables into consideration when developing and executing educational initiatives. The delivery and consumption of education have been revolutionized by the usage of IoT, giving students the freedom to learn from any location. E-learning has also reduced the stress on students' backs and encouraged environmental friendliness by eliminating the need to transport bulky books to college or university. Even if there are obstacles to using IoT in education, including certain pupils who may not adjust to it and an increase in e-waste and electricity consumption, educators can raise the standard of instruction by embracing IoT. The survey discovered that Hyderabad's colleges are gradually implementing IoT devices in learning, and it is expected that the adoption of IoT devices will increase as institutions recognize the benefits of IoT in education.

IoT has the power to change education and make it more accessible, effective, and efficient. The study emphasises the need for additional research and development in this area to fully utilise the potential of IoT in education, even though there is still room for improvement in the implementation of IoT-based applications in education. In order to give students the best learning experience possible as we transition to a more technologically advanced society, it is crucial that we continue to research and invest in the integration of IoT in education.

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