# Educational Inclusion of the Internet of Things in Higher Education: A Literature Review

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## Abstract

*From the growing trend of Internet of Things (IoT), students in their practices do not make use of this technology. This study aims to test whether the educational inclusion of the Internet of Things improves learning in Higher Education. An initial search criteria was used in the databases Scopus, Start exploring, Web of science and Scielo. In each database, use was made of the meta-search engine with the following search criteria: Educational inclusion, Internet of things, learning and Higher Education. As a result of this research, it became evident that students immersed in new technologies and good practices with the Internet of Things favor educational inclusion and improve students' academic performance. It is recommended to develop courses with this technological trend of IoT.*

**Keywords:** *IoT, educational inclusion, learning in higher education.*

## INTRODUCTION

Currently, training processes, teaching practices and learning are required to face new scenarios (Big Data, Internet of Things, personalized platforms, gamification, transmedia, artificial intelligence, etc.). This interpellation finds a certain correlation with the growth of communities and networks of professionals who share thinking, resources, narratives and who articulate formal and informal learning understood from a learning ecology (Lion, 2019).

Educational Inclusion is a process aimed at guaranteeing the right to quality education to all students on equal terms, paying special attention to those who are most excluded or at risk of being marginalized. The development of inclusive schools, which welcome all students, without any type of discrimination, and favor their full participation, development and learning, is a powerful tool for improving the quality of education and advancing towards more just, equitable and cohesive societies (Echeita & Fernández, 2023).

Kevin Ashton, British technologist, expert in digital transformation and father of the "Internet of Things" or "Internet of Things" (IoT), is recognized as one of the world's transforming men for his innovative contributions to technology and society in general (Fernández, 2023). With the new concept "Internet of Things", Ashton intended to achieve through the digitization of objects, an improvement in the quality of life of people.

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The Internet of Things (IoT) describes the network of physical objects ("things") that are embedded with sensors, software and other technologies in order to connect and exchange data with other devices and systems via the Internet. These devices range from common household objects to sophisticated industrial tools (Oracle, 2023).

In this digital era, technologies contribute important support to pedagogical practice and the educational system, demonstrating how important it is to update knowledge in order to accompany society in its constant changes.

Universities have the fundamental role of training life-oriented students, and technologies can be allied in this active learning process, since they are responsible for a great source of knowledge that, if used systematically, can bring great benefits to society.

In this context, the problem statement is Does the educational inclusion of the Internet of Things improve learning in Higher Education? To answer this question, the objective was to check if the educational inclusion of the Internet of Things improves learning in Higher Education.

It is concluded, that students immersed in new technologies, may consider that IoT favors educational inclusion and improve learning.

## METHODOLOGY

To proceed with this literature review, an initial search criteria was used in the databases Scopus, Start exploring, Web of science and Scielo. In each database, use was made of the meta-search engine with the following search criteria: Educational inclusion, Internet of things, learning and Higher Education.

The largest number of articles reviewed corresponds to studies of the Internet of Things in different areas applied to other sectors such as education, climatology, agriculture, health and social, which allowed enriching the understanding of the IOT.

Once the articles were listed, a double-entry table was elaborated, allowing the identification of the variables in each of the articles. Then, the variables were grouped into dimensions that allowed classifying learning with the internet of things.

## RESULTS

From the review of the publications found, they were grouped into 3 predominant factors: Educational inclusion, Internet of things and Learning in higher education.

a.        Predominant Factor 1: Educational inclusion.

Educational inclusion refers to the process aimed at guaranteeing the right to quality education to all students under equal conditions. Said topic has been addressed by different authors (Navarro & Espino, 2012), (Fernández J. , 2017).

Calvo (2013) in his article proposes some ideas for teacher training for educational inclusion. He shows the conceptual change that goes from equity and equality to inclusion as a way to address the characteristic vulnerability of many children and young people in Latin America.

Coherently in the research, Lalama (2018) performs an analysis on the reality of educational inclusion, reporting new challenges that the teacher has had to face until today when assuming the methodological didactic tools to work with inclusion students with special educational needs.

Quintero (2020), mentions that inclusive education is conceived as a process that proposes to recognize and respond to the diversity of needs presented by students so that

their learning is effective, minimizing exclusion inside and outside Educational Institutions.

According to Iglesias and Martín (2019), important changes and advances occurred during the first years around inclusion due, to a large extent, to the influence of the integrating movement initiated in the Nordic countries, the movements in defense of human rights and the permanent claim for the rights of minorities by associative movements, among others, which questioned segregation.

b.       Predominant Factor 2: Internet of Things (IoT)

The IoT can be used in different fields and specifically in the social field, since it can be key to socio-educational and digital inclusion, as mentioned by Extremadera et. al. (2022). This, admits a change that transforms the life of every individual in society. A society with an increasing digital presence and in which the IoT has expanded rapidly. A dual reality, in which the presence of an intangible world becomes more relevant, connecting people through the IoT. A globalized and hyperconnected world, where information flows in large dimensions, so that a good use of it is necessary, as well as an adequate awareness of it and the appropriate tools for its understanding by the members of society.

Rico et. al. (2021), state that organizations, including universities, need to incorporate the "Smart" technologies generated by the so-called fourth industrial revolution, to take advantage of the capabilities they provide to transform their processes and promote new organizational models that allow them to adequately incorporate this new concept of smart university. The rapid disruption of "Smart" technologies makes the traditional way of approaching a large part of the work obsolete. It forces organizations, including universities, to redesign their processes to undertake them in a new and radically different way. This update also includes procedures, organizational structures, mentality and culture to exploit these "Smart" technologies are not yet in place.

Salinas et. al. (2022), in their article mention that currently the use of the internet is part of people's daily lives and having automation systems that interact with the human being, in search of improving the lifestyle to make everyday life easier, increase people's comfort, facilitate tasks and processes in various areas does not seem to be something complicated. Making use of technological advances and innovations can be achieved, technologies such as IoT allows us all of the above while maintaining interconnectivity between electronic devices.

According to Huaman (2019), in his article indicates that the Internet of things refers to the set of physical objects that are part of the everyday life of people, known as wireless node sensors IoT (internet of things), which, in addition to its complexity have Internet connection, and are distinguished by their multifunctional.

For their part, San Martín et. al. (2016), present a review of the Internet of things in the area of healthcare, focusing on the solutions that currently exist in home-oriented healthcare. The Internet of Things applied to healthcare will allow many people, regardless of their social class, to use the services that could be offered through the IoT, which are already being implemented in many countries.

Ramirez et. al. (2022), propose to make an analysis of what the IoT is and what it offers in the different sensors that exist, likewise, to analyze the services offered by Cloud Computing, and what results will be obtained if these 2 new technologies are integrated, allowing them to work together, thereby achieving the generation of new applications, new areas of research and finally what all people are interested in, how to facilitate human life through the use of these technologies.

c.        Predominant Factor 3: learning in higher education

The new information and communication technologies insert progressive changes in the current teaching system, because the influence of technological innovation favors new ways of conceiving learning, as mentioned by Rojas et. al. (2021).

For their part, Poveda and Cifuentes (2020) mention that the challenges and opportunities of the process of using ICT in the field of learning, allow reinventing the educational model, and focusing its attention on the student, since the desire to learn, the use of tools and the permanent motivation to access knowledge is still visible in the being and not in technology.

Bermeo et. al. (2022), indicated that the process of knowledge and technology transfer in the University needs to be analyzed from a dynamic perspective, by recognizing it as a complex system that provides capabilities that improve performance in the face of competition, that allow the circulation of innovations and generate value for the industry.

Barrera et. al. (2022), state that the research shows the effects of applying ABPro as an active and experiential learning methodology to improve students' academic performance. ABPro is characterized as a student-centered methodology, which means that they develop an incentive to become involved in their own learning process by carrying out a project in a real business environment.

According to Díaz (2008), in recent years, the educational offer supported by information and communication technologies (ict) has grown and with it the need for non-formal education spaces with technological support. This is most noticeable in countries with high technological and economic development.

Topic 1.

Classification of the authors, according to the predominant factor in the research.

Predominant factor Authors

Educational inclusion Navarro, Espino/ Fernández/ Calvo /Lalama/ Quinteros/ Iglesias, Martin

Internet of Things Extremadera, Marín, Sanz/ Rico, Maestre, Guerrero, Medina, Areniz, Sanchez/ Salinas, Galván, Guzmán, Orrante/

Learning in Higher Education González, Rodríguez, Álvarez/ Poveda, Cifuentes/ Bermeo, Villalba, Ruiz/ Barrera, Venegas, Ibacache

Topic 2.

Educational inclusion: article and summary of its results

1 Educational inclusion, is it possible? In order to minimize these barriers, it is necessary to set in motion a profound process of change, in which the entire educational community must feel invited to participate. The article discusses two programs that could facilitate the change towards what is called "education for all".

2 Inclusive education. Building paths to move forward the results showed that teachers, regardless of gender, privilege experiential learning by discovery, attending to the premises of meaningful learning and constructivism, being necessary to reinforce the learning scenarios and the didactic strategies they employ, orienting them towards alternative models, mainly in the Science-Technology-Society approach.

3 Teacher training for Educational Inclusion teacher training for educational inclusion requires a call to broad social sectors in order to offer programs that address a broad spectrum of possibilities to develop all the capabilities required by education for human development.

4 Educational Inclusion: Chimera or Reality? These tools allow for the emergent training of teachers to provide effective psycho-pedagogical support and make curricular adaptations more than a missing link, a bridge that opens roads of opportunities, making educational inclusion more than a chimera, a nascent reality.

5 Inclusive education: trends and perspectives Inclusive education is not limited only to a population group such as disability; on the contrary, it is a broad and complex term that addresses a number of situations with which students coexist, such as inequality, poverty, migration and violence, factors that teachers deal with on a daily basis and that have repercussions in the classroom.

6 Scientific production in inclusive education: progress and challenges Consolidating the educational community as a promoter of inclusion. Attention and efforts should be focused on training teachers who are inclusive, reflective and committed to education.

Internet of things: article and summary of its results

1 Educational and social inclusion of the Internet of Things in neurodiversity They show that social inclusion is synonymous with social integration, as well as that educational inclusion addresses the needs of schoolchildren, favors students' academic performance, social relations among students and implies changes in education.

2 Smart University: Key factors for the adoption of internet of things and big data.The massification of emerging technologies such as IoT, Big Data, Cloud Computing and Artificial Intelligence, the adoption rate is low, partly due to a generalized fear because of the lack of knowledge of information management and smart technologies. One of the trends that stands out in the global practice of smart education development is to design smart technologies and their implementation in the educational process.

3 The impact of the internet of all things (IoT) on everyday life The Internet of Things (IoT) can also make possible a better quality of life for people as it enables, thanks to the access to data, specific services such as security, healthcare, education in a personalized and immediate way making every connected object accessible and available for our use.

4 The Internet of Things as an Emerging Technology in Information Technology In this research work, a review was conducted on the current situation of the Internet of Things, its operation, future prospects, benefits and risks, as well as its application in business, sports, health, education and home; concluding that the internet of things can make people's lives easier, performing activities with less time and effort, however, like any technology, for its proper use, people must be aware of its proper use, informing themselves about everything that the internet of things can offer them; as well as its risks.

5 Internet of Things and home-centered health This reflects a broad advance in IoT-based technologies and network architecture, which provide specific solutions to problems in the health sector, especially in scenarios focused on home-centered health, allowing the maximum use of IoT technology in this area, very commonly called IoT Health.

6 Analyzing the Internet of Things and Cloud Computing Both IoT and Cloud Computing are technologies that will grow and evolve in the future, since today one of the biggest obstacles is the communication channel between them, because the greater the demand for requests, the greater the bandwidth needed, therefore, with the arrival of 5G connections, it will allow the growth and development of the technologies discussed in this document.

Learning in higher education: article and summary of results

1 Learning and the new information and communication technologies The new information and communication technologies give learning a more autonomous character, and at the same time increase its social character, due to the constant development of the web, social networks, virtual learning environments and Internet communities.

2 Incorporation of information and communication technologies (ICTs) during the learning process in higher education The results show the importance of using and adapting technology to serve different learning styles and suggest that technology alone does not constitute a factor of innovation.

3 Systemic vision of knowledge and technology transfer in the university The results were obtained from the reality of the National University; however, these results are valid for other universities because they reveal that the capabilities of the process are sensitive to the budget allocated to them.

4 The effect of Project Based Learning on students' academic performance For the evaluation of its effect on academic performance, two quasi-experiments with different control groups were carried out. The results show that ABPro has a positive and significant effect on students' grades.

5 Education and new information technologies: Towards an innovative educational paradigm? In this process of searching for innovative practices in the use of technology in the field of education, the importance of understanding and transforming the conceptions, beliefs and ways of acting of the actors in education cannot be ignored, an issue that is little addressed when the supposed innovation is based on vertical processes of implementing models conceived only from the logic of the expert or the technologist.

## DISCUSSION

The articles reviewed in this research show that student academic success does not depend on the representation of groups corresponding to ethnic minorities or immigrant students, but depends on the practices and policies of Higher Education and how these are able to influence the beliefs and values of their family environment, both students and teachers themselves.

To address this content, we take the article proposed by Navarro and Espino (2012) where they indicate that inclusive education requires that from each and every one of the areas of knowledge in which teacher training is organized, "attention to diversity" is addressed, and as technological progress is advancing, it is necessary to perform practices with the internet of things. Furthermore through the present research study, an attempt has been made to constitute and analyze the relationship between the following three predominant factors: Educational Inclusion, Internet of Things and Learning in Higher Education. In order to understand the relationship between these factors, articles were analyzed where they consider social inclusion to be very important because of the benefits that such inclusion entails for society. Likewise, the analysis of the articles leads to the conclusion that student learning is feasible, with the use of IoT, considering it a key element for the implementation of inclusive practices. Regarding the Internet of things factor, students immersed in new technologies, and good practices with the Internet of things, favors educational inclusion and improves the academic performance of students.

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