IOT-BASED NON-FORMAL EDUCATION INNOVATION TO PROMOTE GENDER EQUALITY

Reta Meliyani
Non-formal Education Study Program, Faculty of Teacher Training and Education, University of Bengkulu

Email: rethamell107@gmail.com

Abstract

Gender equality remains a crucial topic in education, particularly in non-formal education, which plays a crucial role in reaching underserved groups, women, and vulnerable communities. Advances in Internet of Things (IoT) technology offer significant opportunities to create more inclusive, flexible, and interactive learning experiences through advanced devices and accessible digital systems. This article utilizes a literature review method, analyzing various scientific journals, books, and reports from international organizations related to non-formal education, IoT, and gender equality. The research findings indicate that IoT can expand access to non-formal education, improve digital skills, and empower women through gender-sensitive learning. However, challenges remain, such as the digital access gap, inadequate infrastructure, low technological capabilities, and the risk of gender bias in technology use. Therefore, strategies such as enhancing digital skills, strengthening inclusive policies, and collaboration between the government, educational institutions, and the community are needed. Thus, IoT can become not only a technological innovation but also a driver of social change that strengthens gender equality and supports the achievement of sustainable development goals.

Keywords: Digital Literacy, Gender Equality, Internet of Things, Non-Formal Education, Women's Empowerment

1. INTRODUCTION

Gender equality is one of the key goals of the Sustainable Development Goals (SDGs), which emphasize the importance of providing equal learning opportunities for everyone, regardless of gender, social background, or location. Education is not only a human right but also a crucial factor in driving lasting social, economic, and cultural development. Unfortunately, significant disparities between men and women persist, particularly in terms of access, participation, and learning outcomes. Despite some progress, achieving gender equality in education still requires innovation and a modern approach. In addition to the educational pathways pursued in schools, non-formal education also plays a vital role in ensuring equitable access to education throughout society. Non-formal education is more flexible, open, and tailored to individual needs. For example, institutions like Community Learning Centers (PKBM) help those unable to attend formal education, such as women, school dropouts, and rural residents. However, many challenges remain, such as a lack of facilities, low digital literacy rates, and a gender gap in access to non-formal education.

Advances in digital technology have significantly impacted the world of education, including non-formal pathways. One significant development is the emergence of the Internet of Things (IoT), a system that allows smart devices to connect to each other via the internet to automatically collect, store, and process data. The use of IoT in education is considered capable of creating more personalized, interactive, and data-driven learning. Through devices such as smartphones, tablets, or digital sensors, students can access learning materials anytime and anywhere.

IoT holds great potential to support non-formal education due to its flexible and adaptable nature. With this technology, learning can be conducted remotely, training activities can be directly supervised, and assessment processes can be more objective. For women and underserved communities, IoT opens opportunities to learn new skills, expand business networks, and improve personal skills without having to abandon household duties or be limited by location. This makes IoT an innovative solution for strengthening gender-sensitive non-formal education.

However, the implementation of IoT in non-formal education still faces challenges. The digital access gap between men and women remains significant, especially in rural areas or underrepresented communities. Women tend to have more difficulty accessing technology due to economic, cultural, or

lack of skills factors. Therefore, it is crucial to implement gender-responsive non-formal education, namely a learning approach that considers the specific needs, barriers, and opportunities of women so they can effectively utilize technology.

The successful implementation of IoT in non-formal education also depends on improving digital literacy and inclusive education policies. Digital literacy will help people, especially girls, understand how to use devices and access information appropriately. Meanwhile, inclusive non-formal education policies can ensure that IoT development focuses not only on technology but also on equal access, rights protection, and empowerment of vulnerable communities.

From this explanation, it can be concluded that IoT has great potential to strengthen inclusive non-formal education and promote gender equality. However, this potential will not be optimally achieved without appropriate strategies to overcome structural, social, and technological barriers. Therefore, this article is written through a literature review to analyze the role of IoT in gender-responsive non-formal education and summarize strategies from the literature that can support gender equality in non-formal education.

2. METHODOLOGY

The research method used in this article is a literature review. A literature review is a research conducted by collecting data or information from various library sources, including books, journal articles, research reports, and official documents relevant to the topic of study (Creswell, 2004). Danial and Warsiah (2009) add that a literature review is a data collection technique that examines theories, concepts, and previous research findings as a basis for formulating a research framework and argumentation. Using this method, researchers do not collect field data but instead critically and systematically analyze previous findings.

In this research, the literature review focused on scientific works discussing non-formal education, gender equality, and the use of the Internet of Things (IoT) in education. Data sources were obtained from reputable international journals, accredited national articles, and reference books relevant to inclusive education and gender issues. Data analysis was conducted using a content analysis approach, which involves identifying, categorizing, and synthesizing key issues, opportunities, challenges, and innovation strategies for IoT-based non-formal education. Thus, the results of this literature review are expected to provide a comprehensive picture of the role of IoT in promoting gender equality through non-formal education.

3. RESULTS AND DISCUSSION

3.1. Results

Previous research has shown that the Internet of Things (IoT) holds significant potential for transforming education, particularly in non-formal education. According to Al-Mutairi, Al-Mutairi, and Khan (2021), IoT can improve learning quality by creating more interactive, efficient systems that utilize real-time data. This also supports the opinion of McRae, Ellis, and Kent (2018), who stated that IoT can create intelligent and adaptable learning environments and help groups that previously had difficulty accessing education. IoT is not only a technological tool but can also be a vehicle for driving social change. According to UNICEF (2021), the use of digital technology, including IoT, can help reduce the disparity in educational opportunities between men and women, especially for women and girls who often face barriers due to cultural and social factors. IoT can narrow the digital divide if complemented by inclusive digital education policies.

A literature review shows that the Internet of Things (IoT) holds significant potential for supporting change in non-formal education. IoT has been proven to improve learning quality with more interactive, efficient, and data-driven systems (Al-Mutairi et al., 2021). IoT also helps create intelligent and adaptable learning environments, reaching groups that previously had difficulty accessing education (McRae, Ellis, & Kent, 2018). Furthermore, UNICEF (2021) states that the use of digital technology, including IoT, can help reduce gender disparities in education, especially for women and girls who often face cultural and societal barriers. IoT can also reduce the digital divide if accompanied by inclusive education policies.

Other findings indicate challenges in implementing IoT, particularly in impoverished communities and rural areas. The OECD (2025) reported that inequality in internet and technology access persists, leaving women in these regions behind in digital education. Darmawan et al. (2024) noted that digital

transformation of education in Indonesia, particularly in rural areas, still faces significant challenges, such as limited infrastructure, high access costs, and low digital literacy.

3.2. Discussion

Research findings indicate that IoT is not just a technological advancement, but also a tool capable of strengthening social empowerment. As expressed by Suomi (2020), women should be at the center of attention in technology education, including through the development of curricula that better support gender equality. According to Somerkoski & Suomi (2020), digital learning materials must be designed inclusively to ensure women have equal access to technology. Furthermore, research by Dake (2023) suggests that IoT can enhance non-formal education opportunities for adults through interactive learning using smart devices. This supports the idea that IoT has significant potential to strengthen lifelong learning. UNICEF (2020) also states that involving women in IoT-based digital education can increase participation in the digital economy and encourage family and community empowerment.

Therefore, this discussion emphasizes that IoT can be a driver of social change if supported by appropriate strategies, such as improving digital literacy, inclusive non-formal education policies, and collaboration between stakeholders. Without these strategies, challenges such as the technology gap, gender prejudice, and lack of infrastructure will hinder the benefits of IoT in promoting gender equality.

Despite its enormous potential, the use of IoT among poor and marginalized communities still faces many barriers. The OECD (2025) indicates that internet and technology access remains unequal, particularly in rural areas, leaving women more vulnerable to digital education. Non-formal education in Indonesia faces obstacles such as limited infrastructure, costs, and low public awareness of technology.

To address these issues, various studies recommend specific strategies. Suomi (2020) emphasizes the importance of prioritizing women in technology-based education, including developing a more female-friendly curriculum. Somerkoski & Suomi (2020) also recommend that digital teaching materials be inclusive so that women have equal opportunities to learn technology. Furthermore, research by Dake (2023) shows that IoT not only supports interactive learning but also opens up broader opportunities for adults in non-formal education.

Practically, IoT can be used in community-based non-formal education programs, such as digital business training and lifelong learning. UNICEF (2020) stated that women's access to IoT-based digital education can increase their participation in the digital economy, thereby promoting economic independence for families and communities. Therefore, IoT is not just a technological tool but can also be a catalyst for social change that can improve equality between men and women.

Based on previous research, it can be concluded that the use of the Internet of Things (IoT) offers significant potential to support innovations in non-formal education that prioritize gender equality. IoT can create a more flexible and interactive learning environment, adapting to the diverse needs of learners, including women and groups who have previously struggled to access education. With sophisticated tools and networked systems, IoT provides opportunities for women to learn at home or in their local communities, thus balancing household duties and educational participation.

However, many challenges remain, such as disparities in technology access, lack of infrastructure, low technological skills, and prejudice against women in using technology. These issues could diminish the benefits of IoT if not addressed appropriately. Therefore, inclusive non-formal education policies, digital training programs focused on women's empowerment, and collaboration between the government, educational institutions, and the community are needed to build a fair and equitable IoT-based education system.

Thus, IoT is not only a technological innovation in education but also a driver of social change that can strengthen equality between men and women. If utilized effectively, IoT can help women acquire new skills, improve their digital capabilities, and contribute more significantly to social and economic development. Therefore, further research and practical implementation are crucial to strengthen the evidence base on the benefits of IoT-based non-formal education in promoting gender equality and sustainable development.

4. CONCLUSION

Based on the results of several reviews, the use of the Internet of Things (IoT) in non-formal education offers significant potential for expanding access to more inclusive and gender-responsive learning. IoT can create a more flexible and interactive learning process, while supporting the empowerment of

women and disadvantaged groups. However, several obstacles remain, such as gaps in technology access, limited infrastructure, and low technological literacy. Therefore, efforts to improve digital literacy, inclusive policies, and collaboration from various parties are needed so that IoT-based non-formal education innovations can truly promote gender equality and contribute to sustainable development.

REFERENCE LIST

Bashir, B., Kumar Singh, A., Kumar, S., Pal, H., Shaazan Muzaffar, M., & Arkam Manzoor, S. (2025). Internet of Things (IoT) in Educational Sector. Ispes 2024, 12–21. https://doi.org/10.5220/0013572400004639

Chandra, A. (2022). Bridging the Digital Gender Divide. 31–44. https://doi.org/10.4018/978-1-7998-8594-8.ch002

Creswell. (2004). Research design: qualitative, quantitative and mixed methods approachesResearch design: qualitative, quantitative and mixed methods approaches Creswell John W Sage 320 £29 0761924426 0761924426. Nurse Researcher, 12(1), 82–83. https://doi.org/10.7748/nr.12.1.82.s2

Dake, D. K., Bada, G. K., & Dadzie, A. E. (2023). Internet of Things (Iot) Applications in Education: Benefits and Implementation Challenges in Ghanaian Tertiary Institutions. Journal of Information Technology Education: Research, 22, 311–338. https://doi.org/10.28945/5183

Danial, E., & Wasriah, N. (2009). Methods for writing scientific papers. Bandung: Citizenship Education Laboratory.

Darmawan, J., & Gede Eko Putra Sri Sentanu, I. (2024). Digital Transformation For Inclusive Education In Rural Indonesia: Realizing Equity And SDGs. Migration Letters, 21(S3), 961–981. www.migrationletters.com

Mcrae, L., Ellis, K., & Kent, M. (2018). Internet of Things (IoT): Education and Technology The relationship between education and technology for students with disabilities. The Relationship between Education and Technology for Students with Disabilities Leanne, Research, 37. http://www.curtin.edu.au/wp-content/uploads/2018/02/IoTEducation_Formatted_Accessible.pdf

Meylani, R. (2024). Transforming Education with the Internet of Things: A Journey into Smarter Learning Environments. International Journal of Research in Education and Science, 10(1), 161–178. https://doi.org/10.46328/ijres.3362

OECD. (2025). Policies for the digital transformation of school education: Evidence from the OECD Policy Survey on School Education in the Digital Age [working title]. OECD Education Working Papers No. 328, 328.

Ojeka, M. (n.d.). Using IoT to improve teaching methods Sammanfattning.Sammanfattning.Somerkoski, B., & Suomi, R. (2020). E-learning Material on Gender Equality in Information System Professions. ACM International Conference Proceeding Series, 174–179. https://doi.org/10.1145/3377571.3377614

UNICEF. (2021). Advancing Girls' Education and Gender Equality through Digital Learning. December.