The Application of Wireless Sensor Networks and Wearable Technologies for Educational Purposes: A Scoping Review

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Past researches in wireless sensor networks (WSNs) and wearable technologies have mostly been conducted in the field of healthcare for the purpose of patients' health monitoring. However, recent studies in WSNs and wearable technologies suggest that WSNs and wearable technologies have also been used for educational purposes. Despite current research exploring WSNs and wearable technologies for educational purposes, it is less clear as to what has been studied on WSNs and wearable technologies for educational purposes and the research gaps which need to be addressed. The purpose of this study was therefore to conduct a scoping review on the use of WSN and wearable technologies for educational purposes. The search was conducted through a scoping review which adopted four academic databases: ACM, IEEE Xplore, ScienceDirect and Springer Link. In total, seven publications were identified based on the inclusion and exclusion criteria. The scoping review identified the extent and range of studies which have been conducted on WSNs and wearable technologies for educational purposes. The findings identified the challenges, benefits, cost issues and technology types associated with the use of WSNs and wearable technologies for educational purposes as well as the research gaps. The findings will inform researchers and professionals who desire to improve learning through the use of WSNs and wearable technologies.

KEYWORDS

Wireless sensor networks, wearable technologies, education.

1 INTRODUCTION

The current literature on wireless sensor networks (WSNs) [1] and wearable technologies [2, 3] suggest the importance and benefit of remote monitoring. Discussions revolving around WSNs and wearable technologies have been discussed in different areas including healthcare [2]. The use of wireless sensors date back to the 1980s when they were first used, these sensors can collect a wide range of information and then send it to another location [12]. A review by Yilmaz et al. [13] details the various ways in which wireless sensors may be used to "monitor" patient's "vital signs." Simm et al. [14] explore how wearable technologies can be developed in association with users to promote healthcare.

In healthcare, sensors and wearables facilitate the prevention of diseases [15], as they relay health information to medical practitioners at another location. A literature review by Appelboom et al. [16] reveals that wearables and sensors are important in healthcare. Sensors and wearables have been developed to monitor several diseases and ailments, including Autism Spectrum Disorder (ASD). Fletcher and Edygahi [15] describe the use of Electrodermal Activity (EDA) sensors to monitor and track the triggers to, and early signs of, ASD attacks. In addition, wearable technology can help in the early detection of breast cancer [17] and the MONARCA wearable system can assist in the early detection of bipolar attacks [18]. The monitoring of blood pressure [19] and the detection of vital signs [13] are also actioned using wearables and sensors.

There is ongoing research into a wearable device which can detect "temperature and pressure within the skull and then dissolve harmlessly into the cranial fluid" [20]. This device will specifically be used to monitor patients who have undergone cranial surgery. Comstock [20] adds that this device can monitor the patient internally for a specific time before it is removed from the body.

Other studies have also examined the possibilities of including wearable technologies in the area of textile and fashion [21,22]. Furthermore, there is a growing body of research on WSNs and wearable technologies for educational purposes [4,5]. Although, these studies have been established in literature, it is less clear as to what exactly has been described in literature regarding WSNs and wearable technologies for educational purposes.

The purpose of this study therefore was to conduct a scoping review of literature which describe WSNs and wearable technologies for educational purposes and identify the research gaps in this area of study. This paper contributes to the body of literature discussing WSNs and wearable technologies for educational purposes. It also aims to identify research gaps in the area of WSNs and wireless technologies for educational purposes. This paper is structured as follows, Section 2 explains the research method applied in carrying out the research. Section 3 presents the findings of the scoping review. Section 4 discusses the findings and concludes the study.

2 RESEARCH METHOD

2.1 Search strategy

A scoping review was conducted on four databases: ACM digital library, IEEE Xplore, ScienceDirect and SpringerLink. A scoping review helps to identify the scope, range and extent to which WSNs and wearable technologies are being applied for educational purposes. It also helps to identify research gaps and future areas in the application of WSNs and wearable technologies for educational purposes. The search was conducted in May 2017. Arksey and O'Malley [6] point to the following reasons for conducting a scoping literature review:

- To examine the extent, range and nature of the research activity.
- To determine the value of undertaking a full systematic review.
- To summarise and disseminate research findings.
- To identify research gaps in the existing literature.

Arskey and O'Malley [6] provided a framework for performing scoping review which was adopted in this study

2.2 Identifying the research question

The research questions for this study, which aided the scoping review are:

- What is the scope of studies on WSNs and wearable technologies for educational purposes?
- What are the research gaps identified in the areas of WSNs and wearable technologies for educational purposes?

2.3 Identifying relevant studies

A search was conducted on four academic databases: IEEE Xplore, ScienceDirect, PubMed and Scopus. Google search engine was also used. The following keywords were used on all searches "wireless sensor networks" or "wearables" AND "education". The search was between 2012 and 2017.

2.4 Study selection

The inclusion criteria were studies published in English, studies which described the application of WSN and wearable technologies for educational purposes. Studies published in journal articles and conference papers were included. Publications emanating from peer-reviewed journals and conferences were included in the study to ensure that publications included in the study were of quality and as such provided reliable information needed in this study. Studies outside the context of education through the application of WSNs and wearable technologies were excluded. Although the search returned 322 records as shown in Figure 1, it was narrowed to a total of seven publications based on the inclusion and exclusion criteria.

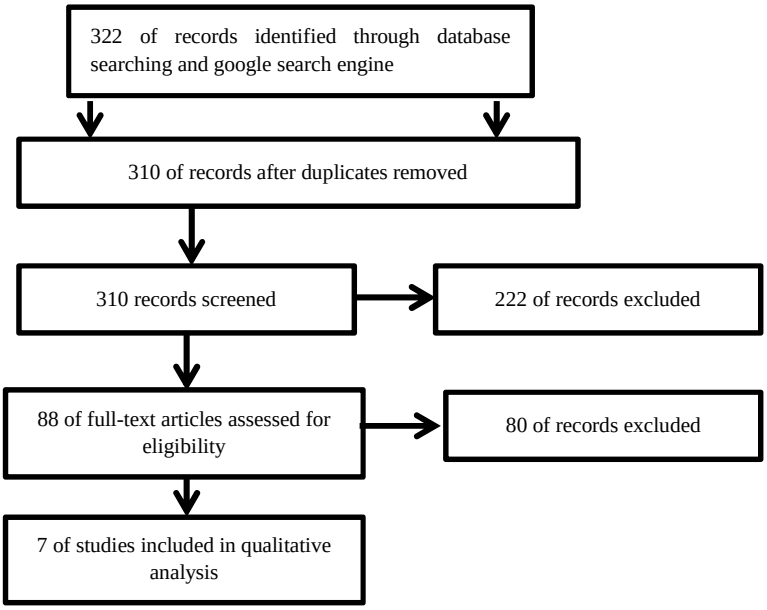

Figure 1 The search process for retrieving the relevant publications on the application of WSNs and wearable technologies for educational purposes

2.5 Charting the data

The data chart for included publications is presented with information about the: publication type, outlet, title, year of publication and key point.

Table 1. Data chart

Publication type	Outlet	Title	Year of publication	Key point
Journal article	Computers and Education	What are the educational affordances of wearable technologies?	2015	The study examines the cost attached to wearable technologies for educational purposes
Conference paper	7th Asia-Pacific Congress on Sports Technology	On the use of inertial sensors in educational engagement activities	2015	This study examines the use of sensors in educational events in secondary schools and higher institutions
Journal article	International Journal of Information Management	Reflective thoughts on the potential and challenges of wearable technology for healthcare	2015	This paper summarises the challenges and potentials of using wearable technologies in healthcare and

		provision and medical education		medical education
Journal article	World Neurosurgery	Use of Google Glass to enhance surgical education of neurosurgery residents: Proof of concept study	2017	This study explores Google Glass as tool for medical education
Journal article	Journal of Surgical Education	Wearable technology for global surgical teleproctoring	2015	The paper examines the use of Google Glass for surgical teleproctoring
Journal article	Journal of Surgical Education	Inheriting the learners' view: A Google Glass-based wearable computing platform for improving surgical trainee performance	2016	This study explores the use of Google Glass for improving surgical training performance
Conference paper	Conference on Human Factors in Computing	Audible beacons and wearables in schools: Helping young visually impaired children play and move independently	2017	This paper explores wearable technologies to help visually impaired children

2.6 Collating, summarizing and reporting results

In total, five journal articles and two conference papers were included in the search. Four out of seven papers included in the study were published in 2015, two papers were published in 2017 and one paper was published in 2016. The papers were analysed individually and placed into themes.

3 RESULTS

In total 7 publications met the inclusion criteria. The following sections explain the themes identified in literature.

3.1 Cost of applying wearable technologies for educational purposes

The cost of acquiring wearable technologies for educational purposes is considered to be high [7, 8] in relation to mobile devices and hence, seen as a challenge for educational purposes [7]. Other aspects regarding wearable technologies for educational purposes include recording and communication [7].

3.2 Technology types

Technologies used in education are inertial sensors for sports science [9], Google Glasses for medical education [8,4]. Other studies [8,4,5,10] have also explained different cases on how Google Glasses have been used for

medical education and surgical education. Datta [5] also identified the following as potential technologies that can be used for educational purposes, GoPro cameras, Oculus headsets, and the upcoming Microsoft Hololens. Audio beacon bracelets [5] for supporting environmental learning of blind children in schools and wearable Arduino LilyPad for learning programming [11] were identified as technologies which can be used for educational purposes.

3.3. Benefits of wearable technologies for educational purposes

In general, wearable technologies are considered useful for educational purposes [7]. Euan [3] also indicated that using wearable technologies for blind children improved adoption to environment for the blind and improved learning.

3.4 Challenges of applying wearable technologies in healthcare

The cost of acquiring wearable technologies for educational purposes is considered high in relation to mobile devices and hence, seen as a challenge for educational purposes [7]. One challenge of applying wearable technologies is battery life as in the case of Google Glass [4]. Datta [5] identified bandwidth as a challenge of wearable technologies.

4 DISCUSSIONS AND CONCLUSION

The objectives of the scoping review were to identify the scope and extent to which WSNs and wearable technologies have been applied in healthcare and to identify the research gaps in the area of WSNs and wearable technologies for educational purposes. This study identified the different topics which have been discussed in the areas of WSNs and wearable technologies for educational purposes and the research gaps will be discussed in this section. Majority of the publications on the subject have been published in journals, specifically medical journals. This indicates that the application of WSNs and wearable technologies for educational purposes have mostly been conducted in the health care domain.

Although some publications identified the application of WSNs and wearable technologies for educational purposes in the area of sports education and environmental education for blind children, the literature indicates that majority of these technologies have been used for surgical education. This is an indication that WSNs and wearable technologies are mostly utilised in the medical field. This calls for more research on the use of WSNs and wearable technologies as a tool for surgical education.

Cost of acquiring wearable technologies seem to be high as indicated in the literature, this suggests the need for decreasing cost in wearable technologies to support education.

Different wearable technologies have been used to facilitate education, with Google Glass being the most popular in the literature. The consistent use of Google Glass in medical education implies that medical schools should see Google Glass as a technology which can be incorporated into the educational domain.

In general, WSNs and wearable technologies prove to be beneficial for educational purposes but other challenges such as power challenges and cost challenges of wearable technologies need to be addressed. There were major limitation of studies on WSN and wearable technologies for directly impacting knowledge and used in a classroom setting. Majority of the studies identified in this study focused on the use of wearable technologies for educational purposes. This indicates the need for more research on the application of WSNs for educational purposes. There was a lack of study on the use of WSNs and wearable technologies for educational purposes in African settings. More research on WSNs and wearable technologies with regards to education should be funded as funding is needed to carryout research in these areas. More research should be conducted in the area of applying WSNs and wearable technologies for enhancing learning in children with mental disabilities.

The study thus, highlights the potential in the use of WSNs and wearable technologies for educational purposes, with a major indication that these technologies can support learning the educational field.

Furthermore, other areas such as teaching mathematics and life sciences with the use of WSN and wearable technologies can be explored. The findings indicate that WSNs and wearable technologies are emerging as tools for facilitating education.

Based on the way the search was conducted, the researchers might have excluded important papers on WSN and wearable technologies for education. Future work would be to conduct a systematic literature review on the subject in which in-depth explanations will be provided on the use of WSN and wearable technologies for educational purposes.

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