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Internet of things platform technology used in undergraduate nursing student education: a scoping review protocol

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ABSTRACT

Introduction Future nursing education needs to build a cutting-edge technology-based educational environment to provide a variety of consumer-oriented education. Thus, the sharing of information in nursing education needs to be considered, especially given the advancement of internet of things (IoT) technology. Before developing a horizontal platform, understanding previously developed IoT platforms is necessary to establish services and devices compatible with each other in different service areas. This scoping review aims to explore the technology used in the IoT platform for the education of nursing students in the undergraduate nursing curriculum.

Methods and analysis A preliminary search was completed to find initial search terms, on which a full-search strategy was developed. Search results yielded from PubMed (NCBI) were screened to ensure articles were peer-reviewed, published in English from January 1999 to August 2021, and relevant to developing, applying and evaluating IoT platforms at educational institutions for students in undergraduate nursing programmes. A full-text review of relevant articles will be conducted, and data will be extracted using the developed extraction tool. The extracted qualitative data will be analysed using a modified grounded theory approach, informing a working definition of the IoT platform and related terms.

Ethics and dissemination The study was exempted from ethical review by the Institutional Review Board of Nambu University, South Korea. Study results will be disseminated through peer-reviewed journals.

Strengths and limitations of this study

► The study will be reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and PRISMA extension for Scoping Reviews (PRISMA-ScR), which are widely accepted approaches for reporting systematic reviews.

► The selected data analysis and extraction method of the review goes beyond simply explaining the internet of things (IoT) platform science and technology used in nursing education, and will explain the field that needs further research or the possibility of convergence with other fields.

► Although this review focuses on the IoT platform for nursing students, lessons learned from this context will be of international interest, given that countries all over the world are engaged in education method transformation through advanced education IoT platform development.

► Because the definition of an IoT platform is not clear, the classification and interpretation of such technology may be difficult.

INTRODUCTION

Klaus Schwab, the founder of the World Economic Forum, forecasted the exponential development of the Fourth Industrial Revolution (4IR) at the 2015 Davos Forum. He said IoT technologies would emerge in the 4IR and converge to create new technologies.[1] Such a trend has led to the emergence of the term *Edutech*, involving information and communication technologies that have become an essential element of education, especially in nursing.[2] In particular, along with the COVID-19 pandemic, the paradigm shift towards applying science and technology in education is expected to accelerate.

During the 2015 Davos Forum, it was also mentioned that the 4IR would spark a major improvement in human mobility.[1] However, this issue is not merely about the human position but the quick and expansive movement of information through modern technology, especially the internet. The information in nursing education should consider the change in human mobility and the concept of sharing through electronic devices. In doing so, the future of nursing education builds a cutting-edge technology-based educational environment that provides a variety of user-oriented education.[3] With the development of internet technology, services for searching, providing and applying necessary information using the Internet have been proposed.

Given these advancements, internet technology has expanded to daily life as the internet of things (IoT). The International Telecommunication Union defines the concept of IoT as 'a global service infrastructure to provide

advanced services by connecting various physical and virtual objects based on information and communication technology'"[4] Similarly, the Korea IoT Association describes the term IoT as 'a hyperconnected internet, in which information is created, collected, shared and used by all things, including people, things, space and data, that are connected through the internet'.[4] Overall, the IoT can be defined as a communication platform for interacting with anything, any place and any time.[5]

An IoT platform is an on-premises software suite or a cloud service (IoT platform as a service) that monitors and may manage and control various types of endpoints, often via applications business units deploy on the platform.[6] However, internet-related services or devices developed so far are dependent on each service platform but are not compatible with services and devices using other service platforms.[7 8] Because of such a problem, it is difficult to develop IoT platforms, given how much time and money is needed to create new services and devices. Therefore, it is necessary to create a horizontal platform for mutual compatibility between services and devices in different service areas,[9] allowing a large number of individuals to interact and collaborate.

In particular, nursing educators must work towards building a smart education environment based on education engineering designs[3] for undergraduate nursing students to consolidate themselves as experts of rich, state-of-the-art technological environments in terms of the adoption, use, and implementation of medical technologies.[10] According to a 2018 survey of nursing college students' IoT-related knowledge and skills,[11] 90% of the respondents were assessed to be at least competent in such abilities, implying that nursing students are already prepared to use IoT technology in their education. In addition, as students' sociodemographic factors affect literacy and learning opportunities, nursing educators need to develop learning plans by combining diverse technologies to provide students with more educational options.[12]

A scoping review is a structural approach to collecting valuable information and resources on a particular topic of interest. It considers a wide range of research questions and the present extent of research done on the topic.[13] It is judged as an appropriate method in identifying background information to develop an IoT platform in nursing education. Therefore, this scoping review aims to provide nursing educators with a foundational understanding of IoT platforms and discussion on the use of advanced education media, highlighting the opportunities it offers for the future of nursing education. It also aims to provide nursing students insight into educational opportunities in rich technological environments, which they are already familiar with and prepared for.

As a scoping review related to IoT in nursing education, various review studies were conducted. These studies included reviews on IoT for basic nursing care focusing on hospital environments[14] and in the medical field, mainly prototyping IoT technology and home care for patients.[15] In addition, a literature review on the benefits and challenges of IoT used in the educational field until 2017[8] and a systematic literature review of how IoT was implemented in academic institutions until 2017[16] were carried out. Moreover, a review study of the IoT platform in the education field analysed the wearables and mobile application platforms within fitness, health education, symptom tracking and collaborative disease management, and care coordination.[17] Previous studies on nursing students about IoT platform technology include a study on undergraduate nursing students' intended use for information and communication technologies and social media platforms for learning[18]; a comparative study on student and faculty attitudes on the use of Zoom, a video conferencing platform[19]; a study on an adaptive learning pilot platform in a graduate nursing education course on pathophysiology,[20] and a study on the implementation of a nursing student clinical assessment tool onto an online platform.[21] Despite various studies on IoT and nursing education, only a few were scoping reviews.

This review explores the science and technology used in IoT for education in the undergraduate nursing curriculum. Moreover, the available evidence will be conceptually mapped, and the differences between the literature will be revealed through a review consistent with the specified scope.[22] The authors will conduct a scoping review of evidence generated by qualitative, quantitative, mixed-methods and other studies to achieve the research objectives. A preliminary search of articles in *JBI Evidence Synthesis*, Cochrane Database of Systematic Reviews and PROSPERO was conducted and completed in August 2021. No current or ongoing systematic or in-progress scoping reviews or systemic reviews on IoT technologies and platforms used in undergraduate nursing education were identified.

Scoping review questions

This scoping review aims to address the following questions:

1. What are the characteristics of the IoT platform used by educators and nursing students in nursing undergraduate education?
2. What are the scientific and technological characteristics and scope of the IoT platform used in nursing undergraduate education?
3. What are the barriers and facilitation factors of the IoT platform used in undergraduate nursing education to prepare for the future nursing education environment?

METHODS AND ANALYSES

This study will be a scoping review. The protocol process of this study was reported according to PRISMA-P,[23] and all procedures will be reported according to PRISMA-ScR.[24]

Inclusion criteria
Participants
This review will consider studies that include nursing students of all grades in the nursing curriculum.

Concept

This study will review research discussing the IoT platform among the scientific technologies used in undergraduate nursing curriculums. For this study, intervention is technology and IoT. Technology includes computing methodologies of medical subject headings (MeSH), digital technology, web-based, online-based, non-face-to-face, network communication, mobile, smartphone and edutech. IoT includes the MeSH term IoT, massively multiplayer online role-playing game, cloud, intelligence, machine and virtual reality. Moreover, the platform was set as the outcome, which includes the virtual learning environment, e-learning environment, e-learning platform, electronic education platform, electronic educational platform, electronic learning environment, electronic learning platform and virtual learning.

In analysing IoT platform technologies, new platform architectures, including perception equipment, access unit, access network, middleware and application,[25] will be analysed first. Then, it will analyse the platform types[26] and the architectures proposed as next-generation programming platforms—client system, data server and judge server—by dividing them into architectures for learners and those for teachers.[27] The concept of this study can be further refined with natural language search.

Context

This review will include the educational setting of an undergraduate nursing programme and exclude graduate, nursing aide and maternity nurse courses and nurse training institutions. Eligible research is not limited to geographical limitations.

Types of sources

This scoping review will consider quantitative, qualitative and mixed-methods study designs for inclusion. In addition, systematic reviews and text and opinion papers will be considered for inclusion in the proposed scoping review. Specifically, this review will consider experimental and quasi-experimental designs, including randomised controlled trials, non-randomised controlled trials, and prestudy and poststudy and discontinued time-series studies. In addition, analytical observational studies, including prospective and retrospective cohort studies, case–control studies and analytical cross-sectional studies, will also be considered. The design of descriptive observational studies, including case series, individual case reports and descriptive cross-sectional studies, will be considered for inclusion. Qualitative research will include phenomenology, grounded theory, ethnography, qualitative explanations, behavioural studies and feminist studies, not limited to previously described studies. Moreover, systematic reviews that satisfy the inclusion criteria based on the research question and text and opinion papers related to the research objective or question will also be included in this scoping review.

Search strategy

The search strategy will identify published literature in various databases and related journals. A preliminary search was performed on PubMed (NCBI) to determine initial search terms. This search used keywords and subject titles found in the list records of related articles to formulate a comprehensive search strategy (see online supplemental appendix I: Search strategy). As this review aims to capture the various terms of IoT or technology, the search was extensive. In addition, to minimise cases where valuable research results could be missed, the scope was limited to Text Word. This limitation may be changed to Title/Abstract later if the scope is deemed too broad. Moreover, the full-text articles included in the final selection will be screened for further study.

This review's search strategy was developed and reviewed by the information search experts of Connected-U.[26] Further research will be done using the Embase (Elsevier), Cochrane Library and Cumulative Index to Nursing & Allied Health (CINAHL) databases. Embase and CINAHL were specifically chosen as the former is the most widely used database for systematic reviews, and the latter has the most comprehensive source of nursing journals. A preliminary search was completed to find initial search terms, and then a full-search strategy was developed. Search results yielded from PubMed (NCBI) were screened to ensure articles were peer-reviewed, published in English from January 1999 to August 2021, and relevant to developing, applying and evaluating IoT platforms at educational institutions for students in undergraduate nursing programmes. According to the preliminary search, IoT first emerged as a concept in 1990.[26] However, the Davos Forum forecasted the emergence of IoT in 2015[1]; thus, the search period may be changed after 2015 based on the amount of searched literature. Once the protocol has been published, the formal data collection for the scoping review will commence and will include more recent publications.

Study/source of evidence selection

All identified literature resulting from the search will be encoded to EndNote V.20.0 (Clarivate Analytics, Pennsylvania, USA), and duplicates will be removed. Then, the titles and abstracts will be screened against the inclusion criteria by one reviewer with consultation from the research team as needed. The full texts of the relevant studies will be retrieved and screened to ensure that the population, concept, and context adhere to the inclusion criteria. Finally, a full-text review of all selected articles will be reviewed against the inclusion criteria by one reviewer. One reviewer will examine the full-text articles following the narrow and well-defined' inclusion criteria. Any ambiguities at this stage will be resolved through discussion with other research team members, and reasons for the exclusion of full-text studies will be reported in the final scoping review report. Furthermore, the search results will be fully detailed in the final report with a Preferred

Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.[28]

Data extraction

Data will be extracted from the studies included in the review using a data extraction tool developed by the reviewers (see online supplemental appendix II: Data extraction treatment). The extracted data will include details on the study type, population, setting, objectives, research questions and terminology/descriptions used, including provided definitions, purposes and principles, IoT platform type, IoT platform function and IoT platform technology as relevant to the objective of this scoping review. Specifically, the qualitative data will be analysed using a modified grounded theory approach, informing a working definition of the IoT platform and related terms. The Modified Ground Theory, which does not focus on the concept derivation but recognises the 'structural process' through context, process and condition consequence matrix,[29] is considered an appropriate method for analysing qualitative data from this study.

The data extraction tool may be modified according to the information that emerges as relevant during the review, and such amendments will be detailed in the full review. In case of missing or needing additional data, the authors of the selected articles may be contacted as needed.

Data analysis and synthesis

Full-scale data analysis will be carried out to examine the articles according to the review questions. The search results will be presented in tables based on the data extraction tool and include information on the study type, population, setting, objectives, research questions and terminology/conceptualisations used in the relevant papers. These results will also be compiled into a working definition of the IoT platform related to undergraduate nursing students. Descriptive, theoretical, methodological and resulting data will be synthesised in tabular form. Results regarding IoT platform barriers and facilitation factors involving disintermediation used by researchers will be presented through a narrative synthesis.

Ethics and dissemination

This study was exempted from ethical review by the Institutional Review Board of Nambu University, South Korea (1041475-2021 HR-030). Study results will be disseminated through peer-reviewed journals.

Discussion

The purpose of this scoping review is to characterise the literature related to IoT platforms used in undergraduate nursing education. Doing so is critical in an era where nursing educators must strengthen future nurses in responding to global, national and local health challenges. We believe that the study's results will provide helpful information to educators who develop nurses' theoretical knowledge, clinical nursing educators who equip nurses with practical skills and university undergraduate educators who design and operate the curricula for future nurses. This scoping review is limited by not including a planned quality assessment of the records as recommended by the methodological framework; thus, the recommendations may impede implementation. Moreover, it can often be difficult to synthesise results from different sources of information. The advantages of this scoping review include adopting a systematic approach, adherence to rigorous and accepted methodological frameworks, and the inclusion of multiple sources of information. The screening team is working closely with nursing educators with extensive experience in nursing education, IoT platform experts and data searchers.

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