Title: Digitising nursing: A theoretical and holistic exploration to understand the adoption and use of digital technologies by nurses

Abstract:

Healthcare is rapidly and increasingly becoming digitalised. As such, it is essential that nursing professionals, the largest professional group within healthcare, can effectively adopt new technologies and contribute to ongoing innovation efforts. However, there is evidence that the process of digitalisation faces barriers from within the nursing profession, and this may contribute towards under-utilisation of already-available technologies. This under-utilisation could lead to missed opportunities to improve the quality of health care systems, services, and population health.

Digital technology implementation in healthcare has often been viewed through a technologically deterministic lens, omitting to consider the potential social impacts of the unique demography of the nursing profession on its subsequent use of these technologies. This paper applies the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine how key demographics of the nursing profession such as gender, age and the voluntariness of use of health technologies may intersect and interact to influence the adoption and use of digital technologies by nurses.

In doing so, this paper provides a novel application of UTAUT beyond a single technological innovation, to consider how the implementation strategies for health technologies within the nursing profession need to be based on an understanding of how best to engage the workforce who will use them.

Relevance to clinical practice:

Without a holistic approach to the implementation of technology, challenges associated with the uses of digital technology by nurses are likely to persist. By considering the moderating demographic factors highlighted within the UTAUT nurse leaders and technology developers may have greater success obtaining greater clinical outcomes from digital technology. This work was completed in 2022.

No Patient or Public Contribution:

Due to the focus of this article being one of professional challenges within the nursing profession, no involvement from patients or the public was sought.

What does this paper contribute to the wider global clinical community?

- A discussion of the role of moderating demographic factors (gender, age, voluntariness of use and experience) as per the Unified Theory of Acceptance and Use of Technology in the digitisation of nursing practice.
- A synthesis of the evidence indicating how implementation of digital technology might be achieved with greater success within the nursing profession.
- Identification of targets for future research to support the digitisation of nursing practice.

Keywords: Digital, technology, innovation, acceptance, diversity, gender, UTAUT, age

Introduction:

The advent of the fourth industrial revolution has seen digital technologies, such as smartphones, social media, digital resources and software applications introduced into all aspects of life and the increasing digitisation of working practices worldwide (Susskind & Susskind, 2016). The COVID-19 pandemic has also hastened the adoption of new digital technologies in many industries. In the context of healthcare, it is arguable that digital transformation is directly linked with health professionals' acceptance and use of technologies, alongside having the necessary digital skills (Huma Sikandar et al., 2022). This has become a requisite for safe and effective service delivery in an increasingly digital environment.

The value of using technology in healthcare has inspired some contemporary healthcare theorists to suggest that technological competency is itself an expression of caring (Locsin et al., 2021; Krel et al., 2022). The authors of this theory emphasise that technological developments are mechanisms to inform care and the competent use of technology can enable that (Locsin et al., 2021). The creation of new technologies by health professionals has also been suggested as an equally important expression of care (Bahari et al., 2021). Indeed, the exploitation of digital technologies to improve clinical outcomes and better understand the needs of patients has been the focus of much discussion recently (Tortorella et al 2021). This has notably been highlighted by the high dependence on rapid access to centralised healthcare data collected digitally throughout the COVID-19 pandemic which was crucial to support decision making by senior healthcare leaders (Budd et al., 2020).

The use of big data to support developments in healthcare is arguably reliant on digital technology usage on a broad scale. Without widescale usage, staff investment in accurate data input and operation, and well-integrated digital systems, the data yielded from our digital technologies is of little value. Healthcare professionals must be able to recognise the potential value of technology and data and ideally be involved in the development of new digital infrastructure to ensure that digital technologies work for our healthcare systems, our patients, and answer the questions which traditional research methods are unable to answer. Existing research on the utilisation of such technologies has found improved health behaviour and treatment compliance (Ibrahim et al., 2022), satisfaction of patient information needs (Allen et al., 2016; Vasilica et al., 2021; Garwood-Cross et al., 2021) and improved service metrics (Wynn & Scholes, 2022). Digital technologies can be utilised in a number of ways such as utilising digital data to improve health research, joining up provision between services, and improving patients' self-management of conditions to influence health outcomes.

Background

In nursing practice, despite the advantages of utilising digital technologies, there are challenges associated with implementing and sustaining their use. For example, in a recent survey of wound care clinicians, predominantly nurses, in the United Kingdom (UK) almost none used contemporary smartphone technology in their practice despite 99% of study participants having access to smartphones and 58% having access to more than one device (Wynn & Clark, 2022). Similar findings have been noted in relation to the adoption of electronic health records (Arikan et al., 2021) despite being a key focus of contemporary digitalisation efforts which has repeatedly failed to materialise for over 20 years (Burke, 2002, Rumball-Smith et al., 2020). This may due, in part, to resistance to an ever-shifting technological landscape. In 2018 the UK Health Secretary ordered that fax machines be phased out from the National

Health Service (NHS) after it was discovered that more than 8,000 were still in use in NHS trusts, and placed a ban on their use from 2020 to hasten a move towards more modern technologies such as secure email for communication (Department of Health and Social Care, 2018). However, in 2022 it was reported that over 800 fax machines are still in use in NHS trusts (Gross, 2022) showing a potential resistance to modernise in line with changes in technology.

Nurses' resistance to digital technology implementation is not a new phenomenon (Wilson, 2002; Timmons, 2003; Kirkley & Stein, 2004; Sweis et al., 2014; Salzmann-Erikson & Eriksson, 2016). A study by Timmons (2003) highlighted nurses resisted the implementation and use of computer systems in a variety of ways including avoidance, extensive criticism and in rare cases refusal of use. In some cases, this linked with nurses' concerns about reliability, over-reliance on technology, the degradation of skills or needing to complete digital plans away from patients, which mirrored findings from Wilson (2002). Whilst these studies are now approaching 20-years-old, they highlight that resistance to a fast-changing technological landscape has been observed in nurse populations for some time. Moreover, Timmons (2003) highlights that resistance to technology should not just be seen through the lens of being irrational technophobia but should be considered an indication of systems failures. We take this argument a step further to suggest that it may also be indicative of failures to provide implementation strategies that acknowledge the population the technology is being implemented within. Contemporary studies and reviews typically focus on technologies in terms of their functionalities, usability, acceptability, uptake, efficacy, and impact on health outcomes, with little prior emphasis placed on the needs, expectations and requirements or technological habits of the target demographics of the digital technology users themselves.

In this paper we demonstrate how the moderating factors identified within the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) can be used as a lens to undertake a holistic analysis of the nursing profession for digital technology adoption. As nursing roles and populations vary from country to country, we use the United Kingdom (UK) as a case study to demonstrate this however, the UTAUT framework can be applied to other countries and health professions, and we encourage other scholars to do so.

In doing so we aim to identify what understanding this professional population can tell us about how best to implement and develop digital technologies for use with and by nurses for technology acceptance in the profession and identify the gaps in knowledge to be filled by future study. Previous reviews of research using the UTAUT have identified that these moderating factors are rarely included in analyses (Dwivedi et al 2011) and it is rarely used in healthcare contexts compared to other industries (Williams et al 2015). We suggest that by using the UTAUT, gaps in literature and understanding can be identified, and thus targeted for future primary research to fill the gaps required for a holistic understanding of technology implementation in healthcare practitioner populations, in this case, nursing.

The unified theory of the acceptance and use of technology (UTAUT)

The success of technological innovations is not determined solely on the value of technologies themselves. It has long been argued in the field of Science and Technology Studies that there is a mutual shaping between technologies and humans, particularly by Actor-Network Theory (ANT) scholars (Latour, 1987,2005; Callon, 1989; Law, 1992, 2016). Applying this lens of the mutual shaping of technology to digitised nursing, and considering particularly the literature about nurses' resistance to

technologies (Wilson, 2002; Timmons, 2003; Kirkley & Stein, 2004; Sweis et al., 2014; Salzmann-Erikson & Eriksson, 2016), we can see why more thought must be given to the ways nurses and technologies interact. Taking an example from Timmons (2003) study, a new electronic care planning system was introduced, nurses are concerned about how the technology shapes them – they fear it will make them over-reliant on technologies, will degrade their skills, and that system issues will impact care of their patients, therefore they resist the technology by avoiding its use, updating notes on paper and in extreme cases outright refusal to engage with the technology. In a situation like this not only are nurses concerned about how the technology will impact them, but their resistance impacts the implementation of the technology itself. If a technology is not utilised effectively then it may be considered inefficient or have diminished impact, potentially affecting decisions to continue broader implementation. Acceptance of technology is believed to influence productivity, efficiency, and effectiveness (Bhattacherjee & Sanford, 2006). Therefore, it is important to understand nurses' technology acceptance to successfully implement new innovative technologies with this professional group.

Technology acceptance and consumer behaviour research dates to 1978 (Du Plessis et al., 1990). There are a variety of different theories that can be applied when considering technology acceptance and these fall into three main categories; social psychology, information system management, and behavioural psychology (Venkatesh et al., 2003). These theories include the Technology Acceptance Model, Theory of Planned Behaviour, Social Cognitive Theory, Innovation Diffusion Theory, and the Motivational Model. However, Venkatesh et al. (2003) suggest these theories can be limited in unpacking more complex technologies and in response, developed the Unified Theory of Acceptance and Use of Technology (UTAUT) via a synthesis of several of these earlier theories of technology acceptance. UTAUT was therefore selected for this paper as it combines the features of alternative theories and provides a more holistic view of technology use and acceptance.

The theory identifies four predictors of users' behavioural intention with technology including performance expectancy (the degree to which users think a system will help them gain job performance), effort expectancy (the ease of use of the system), social influence (the degree to which individuals perceive that others think they should use a system) and facilitating conditions (the perception of an individual that their organisations technical infrastructure is able to support use of the system). In addition, UTAUT identifies four social / demographic factors; gender, age, experience, and voluntariness of use. These social demographic factors intersect to influence a user's perception of performance expectancy, effort expectancy, social influence and facilitating conditions, thus impacting their behavioural intention and use behaviour of technology as seen in Figure 1.

As technology usage is somewhat linked to demographic characteristics (ONS, 2020), UTAUT is the only theory providing a clear link between immutable demographic features such as gender and age, and factors which may be relatively consistent within a well-defined professional group (I.e. experience with technology and voluntariness of use) (Marikyan & Papagiannidis, 2021) as is possible within registered nurses working within a nationalised health system. Given nursing is uniquely non-diverse in relation to gender in particular, it is possible that this may exert a disproportionate moderating influence on interactions between technology and their acceptance by nurses. This may be compounded by the standardised training curriculums set by the Nursing and Midwifery Council leading to potentially homogenous experiences and expectations of the use of digital technologies in clinical practice along with the culture experienced within a nationalised health system. A recent systematic review indicated

that the UTAUT is still a valid and effective for predicting the use of technologies by healthcare professionals (Rouidi et al., 2022).

While the predictors on the left-hand side of figure 1 are challenging to predict without specific primary data and are likely to vary considerably within different clinical contexts due to variations in leadership, culture, and infrastructure. The moderating factors shown on the bottom of the diagram in figure 1, specifically gender, age and voluntariness of use are arguably relatively predictable or stable within the nursing profession and can therefore be examined in greater depth to provide insights which may assist digital innovators hoping to implement technologies within nursing practice in a more general sense. Therefore, this paper will focus on gender, age, voluntariness of use and experience, to identify existing knowledge of these areas of the nursing profession, or where future primary data is required. The authors are also conducting a study to collect data from UK nurses on all UTAUT domains, therefore this paper represents a first step in interrogating the key demographics and how they may impact implementation of technology with nurses.

Data sources

Although this paper is discursive and not a systematic review of literature, the authors aimed to ensure that peer-reviewed literature was obtained from a range of academic sources. Keywords such as "Unified Theory of Acceptance and Use of Technology," "UTAUT," "digitalisation," "nursing practice," and "technology adoption" were searched on PubMed, CINAHL and Google Scholar to identify literature broadly related to the use of the UTAUT theory. UK government and professional regulator reports related to technology usage and nursing demographics were reviewed to gain insights into current recommendations related to digital technologies in nursing practice and the demography of the profession. In addition, searches focussed on the moderating factor domains were run on PubMed using the search statements below. The last search was run on 26/04/2023.

The details of the search statements used can be seen in appendix 1. The searches were conducted and screened for relevance by two of the authors XX and XX. UK sources were prioritised, however where insufficient literature from a UK or nursing context was found, the authors noted the need for future primary data and have drawn on data from other countries or broader studies to provide awareness of possible future findings.

Findings

Who are nurses?

According to the most recent data available on the nursing profession in the UK, there were 704,520 nurses on the register in March 2022 (NMC, 2022). Of these registrants, 89% are female, typically between 31-50 years of age and are mainly of white British ethnicity (71.9%) and 24.7% from Asian and Black minority ethnic groups. Only a small proportion of nurses have recordable qualifications indicating further study (n=126,843, 18%) although this may be an underestimation of nurses who have undertaken additional training / education as not all courses lead to recordable qualifications. Since 2013, all nurses have been required to complete an undergraduate degree prior to registration as a nurse as such a there is potentially a substantial proportion of nurses who do not have a university education and that a demographic shift in relation to education is currently underway in the UK nursing context. Some changes in demographics are notable within the NMC (2022) data including a reduction in

nurses from the European Union following the UKs exit from the EU in 2016 decreasing 4.8% from 35,115 to 28,863 over the five-year period from 2017-2022. This has accompanied a 60.3% increase in nurses from outside the EU which have increased from 68,434 to 113,579 over the same period with most of these nurses coming from the Philippines and India. The data broadly indicates that the current nursing workforce is eclectic comprising of both UK and internationally trained nurses, some of which trained before 2013 when nursing became a graduate profession in the UK and as such their digital preparedness is likely broad.

However, from NMC data, the key demographics of the UK nurse can be summarised as typically, female, aged between 31-50, educated to at least a diploma level and of white British ethnicity. It could therefore also be assumed that most UK nurses have experienced contemporary British digital culture and access to technologies as per current norms within the UK. According to the Office for National Statistics, in 2020 96% of UK households had internet access, 76% of adults used internet banking and 87% shopped online. Of adults aged 25 to 34 years, 49% reportedly used virtual assistants, smart speakers, or apps. This dropped considerably in those aged over 65 to just 17%. This data helps generate an image of the contemporary experience of the nurse and their potential relationship with technology. They are likely to use digital technology to manage their finances, utilise smartphone applications and possibly virtual assistants. This is suggestive of both a level of competency to use digital technology, good access the internet and trust that these technologies are secure enough to manage their money with. Considering the above factors, it is necessary to review in more granular detail how these demographic factors may influence the acceptance and use of technologies by nurses in the workplace.

Gender

Nursing remains a predominantly female profession, with 24 million of the 28.5 million nurses globally being women (World Health Organisation 2019), and the UK nursing population being 89% female (NMC, 2022). The UTAUT highlights gender as a factor in acceptance and use of technology, therefore it is valuable to question what impact this might have in a majority-female profession, and how technology implementation for this population might be rethought accordingly. Our search identified no existing studies related to the impact of gender on UK nurses' technology acceptance or usage, therefore further research is required to draw clear understandings of how gender impacts acceptance in this population. Whilst no demographic group can ever be assumed to be homogenous in their thoughts, feelings, or skills, by considering some of the existing literature around gender and technology adoption we may be able to reveal under-considered ways of supporting the technology adoption of nurses.

A review by Goswami and Dutta (2016) investigating differences in the usage of technology associated with gender highlighted several common factors across a range of technologies including the use of social media, e-commerce, online banking, and e-learning platforms. Critically the study reviewed studies from across the globe including from the UK, Malaysia, Nigeria, Singapore, Taiwan, Brazil, and others indicating that consistencies in findings are unlikely an artefact of any country's unique cultural features with regards to gender. The authors found that females tended to use technology which requires less effort to use than men indicating that effort expectancy is a greater predictor of technology acceptance in females than males. Social influence was also found to be greater among females than males indicating that gender also moderates this predictor to a greater extent in female populations. Notably, this was also observed in the usage of technologies with females generally making more use of

social media platforms and demonstrating more sensitivity to customer reviews when using e-commerce services than males. Critically, females were reportedly more likely to adopt technologies due to social influence than males who are more likely to adopt technologies due to personal choice. Other patterns identified included increased concerns about privacy by females than males and variations in perceptions of self-efficacy. Females reportedly demonstrated higher levels of anxiety and reduced perceptions of self-efficacy in relation to using technologies than men. However, this study examined the use of technologies by individuals for personal reasons and not in a work context. Despite this, the clear differences between how males and females use technology is arguably likely to be consistent in its moderating impact even in a professional context and should be considered. The results of a recent study evaluating the adoption of digital technologies in nursing practice in Germany reflects these findings, reporting that usability was the dominant reason for non-adoption of technologies alongside perceptions of benefits (Seibert et al., 2020).

The findings of the Goswami and Dutta (2016) study were repeated in a later systematic review and meta-analysis examining gender attitudes towards technology by Cai et al. (2017). This later review also used a sample drawn from across North America, Europe, Asia, and others and examined the data across a 20-year period. They found that males showed more favourable attitudes towards technology, while females demonstrated lower self-efficacy and levels of belief in the utility of technology. Notably, the authors reported that, across the 20-year period, the data indicated little change in lower levels of positive attitudes towards technology among females despite changes in the capabilities and ubiquity of technology in society. It has been proposed that these variations in attitude and perception may be a result of the widespread perception of technology as a male-dominated field, although there has been little enquiry into the causation of varying attitudes between genders. Given the specific nature of the disparities between genders it appears unlikely that focussing on the unique factors influencing acceptance of technology by females will reduce their usage by the minority of male nurses. However, it is evident that failing to consider these factors may have a disproportionate impact on the majority of the nursing profession and could risk a reduction in the acceptance and sustainability of technologies within nursing practice. Notably, the Cai et al. (2017) study demonstrated that the differences in attitudes towards technology between males and females were both statistically significant and stable over the period of 17 years for which data were available. Whilst the reasons for this remain poorly understood, it highlights considerations when implementing technologies as to how the benefits, design and skills required are presented.

These findings raise interesting considerations for how we introduce digital innovation into healthcare systems. When introducing new technologies into healthcare the focus is often on the time and money-saving benefits of these technologies as motivators for adoption. In fact, in most cases demonstration of economic benefit is essential for end-users to justify adoption of the technology (Guo et al 2020). Thereby creating a paradox whereby no successful implementation means no evidence and therefore no adoption and vice versa. However, taking the UTAUT into consideration highlights that to effectively implement technology in a female-dominated profession such as nursing efforts must be made to appeal particularly to the factors that motivate females to adopt technology, such as social influence. This might be done through highlighting the benefits to patients' wellbeing, sharing the value of building communities of practice through technology, or the introduction of professional role models to emphasise the benefits of technologies in the workplace. Likewise, recognising that effort expectancy is important to women provides opportunities for those developing technologies for the female-

dominated nursing profession to account for the importance of ease of use, with intuitive and effective user design, rather than adding unnecessary features which may over-complicate the technological innovation and have a negative impact on user perceptions of effort expenditure needed to adopt the technology.

Considering the existing research on gender variations in technology acceptance and use, increased efforts may also be required to improve perceptions of self-efficacy when it comes to digital skills with nurses. At present, there is a scarcity of studies to understand how nurses as a professional group perceive their digital skills, and further research is needed to develop this understanding. In 2017, Health Education England (HEE) and the Royal College of Nursing (RCN) produced a report on improve the digital literacy of the nursing profession. Within which definitions of digital literacy, 'e-nurse' and approaches to improving digital literacy are described. However, the research from which this report was based did not focus on the nursing profession but instead looked at data related to trainees, learners and employees in healthcare and industry more widely and is therefore unlikely to account for the unique demographic features of the nursing profession (de Normanville & Scott, 2016; de Normanville, Scott & Speake, 2016). Critically, the literature review underpinning the HEE / RCN report found that there is little, if any evidence of evaluation of the impact that a digital literacy strategy has upon any specific workforce's performance (de Normanville & Scott, 2016).

Given that nursing is a female-dominated profession, and the research suggests women may have lower confidence in their digital skills, efforts to improve nurses' perception of their digital skills and develop those skills further may aid in the adoption of technologies within the profession. This could be in the form of dedicated digital skills training programmes utilising pedagogical approaches which build confidence with technology and harness the impacts of social influence to moderate intentions to use technology in future practice. This would also be consistent with the World Health Organisation's (2021) strategic Directions for Nursing and Midwifery which emphasises the need for nurses and midwives to be educated with cross-cutting competencies including culturally appropriate care and the use of digital technologies.

Age

In a UK context, the NMC publish descriptive statistics of registrants ages, which gives us an insight into the age demographics in nursing and midwifery. This data (NMC 2022) highlights that the profession is an ageing profession with most nurses falling between ages 31-50. Beyond the descriptive statistics published by the NMC on the age of UK registrants there is currently little data on the age distribution of nurses working at different levels within the NHS. In addition, due to the relatively unstructured nature of nursing careers in the UK it is difficult to predict at what age a nurse might be at any given level within the professional hierarchy. Compounding this, there is currently no requirement to register senior positions such as managerial or most specialist clinical positions which may indicate positions of formal authority and potentially grater social influence over more junior nurses. This makes is challenging to predict how age may influence nursing services as there is currently no data available indicating the age diversity of nurses in roles where key decisions might influence adoption of digital technologies.

Whilst there appear to be no studies exploring the role of age in a UK nurse-only context, a recent study looking at the adoption of mobile health technologies and recommendations of their use for patients by NHS health professionals, including nurses, found that age was a significant factor (Leigh et al 2020). The authors noted that HCP over the age of 46 were considerably less likely to recommend the use of mobile

health technologies to patients. Although it is important to note that nurses made up only a small proportion of the sample in this study (n=27/185). This may reflect higher self-reported digital competence among younger HCP which was indicated in a study of 27 UK primary care facilities (Hammerton et al 2022). A recent Italian study by Barchielli et al (2021) investigating nurses' acceptance of innovations in technology-intensive contexts also supports the hypothesis of age as a key factor in the nursing-technology context. They found that age is a key moderator for social influence and that older nurses appeared to be influenced less by social factors. The authors suggest this may be because younger nurses are more dependent on others whilst older nurses may feel more confident and therefore less influenced by others. This may indicate the compounding impact of older nurses who are more likely to be in positions of formal authority having a disproportionate influence over younger nurses who are more likely to yield to their social influence as leaders because of both their younger age and being (mainly) female. However, there is currently limited evidence on how age impacts on technology usage amongst nurses.

Age should be included as a variable in future studies evaluating the usage of technology by nurses to provide more evidence on how this factor affects technology usage. These sentiments are reflected in the recently published 'What Good Looks Like Framework' by NHS England (2021), which highlights the need for a people-centred approach to digitalisation of healthcare services.

Voluntariness of use

This moderating factor relates to the degree to which use of a technology is perceived as being voluntary or of free will. Currently nursing teams have varied abilities to either adopt or reject new technologies dependent on factors such as budgets, leadership, and cultural factors. However, as mentioned at the beginning of this paper, there have been instances of the use of technology being forcibly altered within the NHS, such as the ban on fax machines by the Department of Health and Social Care (Department of Health and Social Care, 2018). Whilst the authors were unable to locate data on forced changes to UK nurses' use of technology, Chiu and Ku (2015) noted that when physiotherapists in Hong Kong had electronic health records made mandatory, dependent on ease of use, they were more resistant to these technologies than they had been when they were voluntary. Whilst this study was not conducted with nurses, it highlights the potential resistance against mandatory use of technologies in a healthcare context. A broader study of HCP by Leigh et al (2020) also found that an 'NHS stamp of approval' may increase the likelihood of HCP recommending the use of mobile health applications to patients. However, again this study did not focus explicitly on nurses and may not account for the more specific social and cultural influences guiding perceptions of voluntariness of use in the nursing context.

This could be compounded by the lack of inclusion of nurses in the design and development of new technologies. Nurses are rarely involved in the development of new technologies (Seibert et al 2020) and have mixed feelings about the mandatory implementation of technology (Nguyen et al 2016). These studies highlight the need to nurses to be engaged in the creation and implementation of technologies to increase their voluntariness of use. The impacts of mandatory use of technologies may also hinder innovation and degrade nurses' sense of agency to act within the new universal technological domain. Rather, nurses should be encouraged to increase their agency as digital healthcare workers and see themselves as digital innovators able to actively shape technologies useful to their practice, rather than having technologies introduced compulsorily. Seibert et al (2020) support this notion and argue that greater emphasis on multidisciplinary development teams is required to support innovation. Curtis &

Brooks (2020) highlight in their UK study that co-creating nurse-led initiatives for implementing digital health technologies in nursing homes required a whole-team approach that listens to nurse concerns and prepares the nursing home workforce for digital implementation. According to Booth et al (2021) nurses must adapt for the digital age by re-conceptualising nursing practice to account for the new demands on nursing professionals with regards skills, knowledge and leadership and the disruption to traditional nurse-patient relationships caused by technology. The Philips Ives review is currently underway in the UK to generate evidence and inform strategy to ensure that nursing professionals have the knowledge skills and education to operate effectively in an increasingly digital care environment.

Experience

While numerous studies have delved into nurses' experiences with specific technologies in practice, comprehensive research focusing on nurse experiences of technology use and implementation in a broader sense remains scarce. For instance, we could find no investigations into nurses' personal philosophies concerning digital technologies based on their experiences, which may subsequently influence future or ongoing interactions with digital technologies. However, comprehending nurses' experiences with technology and their capabilities related to digital skills is crucial as healthcare systems progressively adopt digitization. A study by Hammerton et al (2022) identified that self-reported competence was higher for EPR (Electronic Patient Record) technology than patient apps and wearables and social media among primary care staff in the UK potentially reflecting the level of experience associated with these technologies. However, this study was not focussed on nurses and data were not disaggregated to allow closer analysis of this specific population.

Inadequate digital competence has given rise to new types of potential healthcare-associated harm. A prime example is e-iatrogenesis, described by Weiner et al. (2007; p1) as "patient harm caused at least in part by the application of health information technology." Often, substandard medical data processing systems contribute significantly to medical errors (Adane et al., 2019), such as medication errors (Gupta & Moran, 2018). The experiences of nurses in relation to digital technology must therefore be the focus of further investigation to help guide efforts to upskill the profession and focus on technologies that nurses may have less experience with.

Discussion

This paper has considered four elements impacting UTAUT (gender, age, voluntariness of use and experience) which intersect with performance expectancy, effort expectancy, social influence and facilitating conditions. By interrogating categories this paper lays the foundation for further exploration of the UTAUT in nursing and highlights the need for further primary data on UTAUT domains in the UK nursing population. To account for the moderating impacts on performance expectancy, effort expectancy, social influence and facilitating conditions, individuals aiming to implement or develop new technologies for nurses must consider these factors. Crucially the evidence for how these demographic characteristics intersect to influence the use and acceptance of technology must be investigated further to support ongoing digitalisation efforts within the nursing profession.

Recognising how these elements may have a mediating effect on other aspects of technology acceptance and use also allows us to consider how those charged with implementing technology in healthcare can alter their implementation strategies to appeal to nurses' unique intersections. It is also valuable to consider how this mapping of healthcare professionals unique demographics and

perspectives using ATAUT may be valuable in other health professions, particularly those where the demographics of the profession are more homogenous and may have strong moderating impacts on overall technology acceptance and use.

In addition, performing this first stage of a holistic UTAUT analysis of the nursing profession has highlighted that despite implementation of technology within the UK NHS being a process that has been going on for 20 years (Wilson, 2002; Timmons, 2003), the literature and data required to perform a full holistic UTAUT analysis of the nursing profession in relation to technology acceptance and use is still not readily available. As such, the authors have used the framework of both UTAUT and Actor Network Theory discussed in this paper to shape the collection of data from UK nurses about their digital capabilities, perspectives on digital technologies and training need for digitalisation.

Conclusion

Healthcare services are changing because of rapid advances in technology, particularly digital technologies. To remain relevant and effective nurses must adapt to this new context, this includes a shift in the epistemology of professional nursing to account for the new digital environment within which care is delivered. The development, implementation and adoption of new digital technologies allowing new and improved nursing capabilities must be a priority of nursing and healthcare leaders. As the largest healthcare profession, nurses must also be a key focus of the digitalisation process. By considering the demographic makeup of the nursing profession in relation to gender, age and the current voluntariness of use of technologies by nurses as per the UTAUT, a clearer analysis of the nursing situation can be attained to support ongoing efforts to engage the profession in digitalisation. It is evident that further work is required to develop insight into how the factors explored in this article may influence the adoption of digital technologies by nurses. However, the current data indicate that factors which may increase the adoption of technologies by nurses may include; greater emphasis on usability than functionality; engaging nurses who are effective social influencers as part of implementation processes; feedback systems built into digital technologies to allow nurses to visualise how the technology impacts patient care; age diversity among nurse leaders and greater understanding of nurse perceptions of their voluntariness of use of technologies. Finally, it is evident that nurses must take greater roles in the development of new technologies in future, which will inevitably require the development of new digital skills not traditionally considered part of nursing curricula such as developing proposals to create new technology or improve existing technology. It is recommended that the UTAUT factors are considered as part of the implementation of any new technologies within the nursing profession, and that similar work may be conducted around other healthcare professions with similar slightly homogenous demographics.

For example, demographic patterns such as age, gender, and education level can influence nurses' perceptions of digital technologies and their willingness to adopt them in their practice. Moreover, social and organizational factors, such as perceived usefulness, ease of use, and support from colleagues and management, can also play a critical role in shaping nurses' attitudes towards digitalisation.

Relevance to clinical practice

The issues highlighted in this article are relevant to nurse leaders and those responsible for implementing technologies within nursing contexts. They are also relevant to technology developers

who may benefit from considering the evidence associated with the moderating demographic factors highlighted in this article.

Without a holistic approach to the implementation of technology, challenges associated with the uses of digital technology by nurses are likely to persist. By considering the moderating demographic factors highlighted within the UTAUT (age, gender, voluntariness of use and experience) nurse leaders and technology developers may have greater success obtaining greater clinical outcomes from digital technology.

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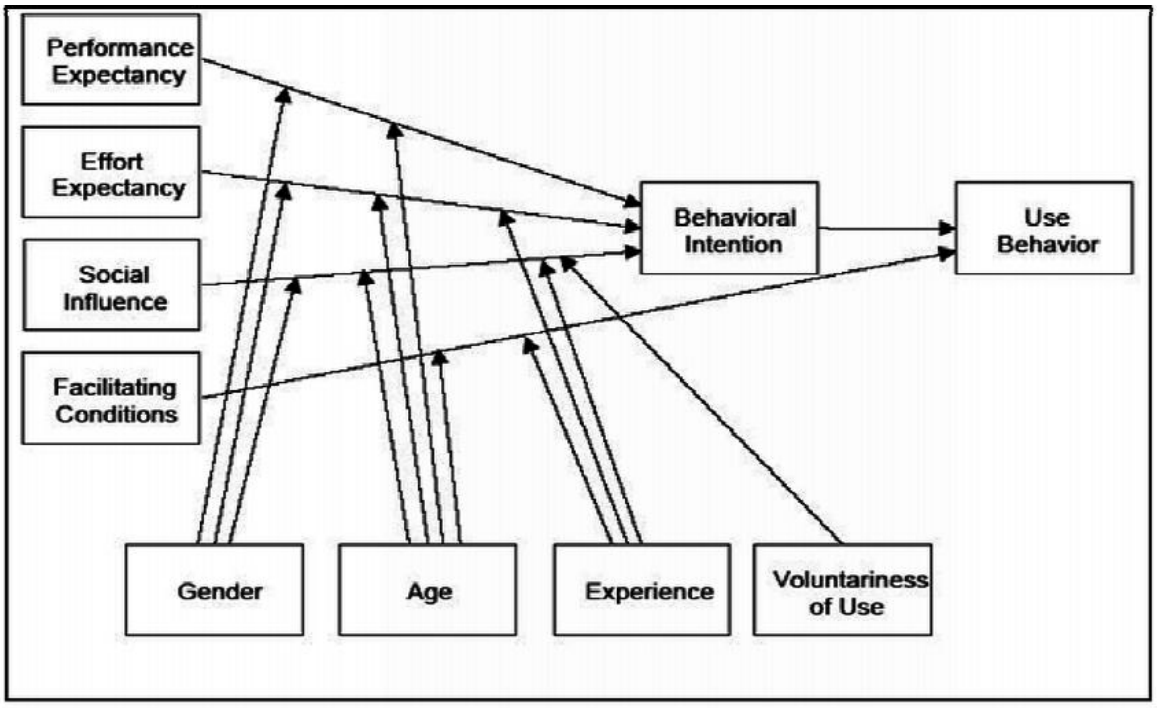
Figure 1. Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003).



Appendix 1.

Gender:

((Nurs*[Title/Abstract]) AND (technology[Title/Abstract] OR digital[Title/Abstract] OR electronic health record[Title/Abstract] OR EHR[Title/Abstract] OR app[Title/Abstract] OR devices[Title/Abstract])) AND (gender[Title/Abstract] OR female[Title/Abstract] OR male[Title/Abstract] OR women[Title/Abstract] OR men[Title/Abstract]) AND (acceptance [Title/Abstract] OR adoption [Title/Abstract] OR usage[Title/Abstract] OR utilization [Title/Abstract] OR implementation [Title/Abstract]) AND (UK[Title/Abstract] OR United Kingdom [Title/Abstract] OR England [Title/Abstract] OR Northern Ireland [Title/Abstract] OR Scotland [Title/Abstract] OR Wales [Title/Abstract])

Age:

((Nurs*[Title/Abstract]) AND (technology[Title/Abstract] OR digital[Title/Abstract] OR electronic health record[Title/Abstract] OR EHR[Title/Abstract] OR app[Title/Abstract] OR devices[Title/Abstract])) AND (age[Title/Abstract] OR older[Title/Abstract] OR younger[Title/Abstract] OR young[Title/Abstract]) AND (acceptance[Title/Abstract] OR adoption[Title/Abstract] OR usage[Title/Abstract] OR utilization[Title/Abstract] OR implementation[Title/Abstract]) AND (UK[Title/Abstract] OR United Kingdom[Title/Abstract] OR England[Title/Abstract] OR Northern Ireland[Title/Abstract] OR Scotland[Title/Abstract] OR Wales[Title/Abstract])

Voluntariness of use:

((Nurs*[Title/Abstract]) AND (technology[Title/Abstract] OR digital[Title/Abstract] OR electronic health record[Title/Abstract] OR EHR[Title/Abstract] OR app[Title/Abstract] OR devices[Title/Abstract])) AND (voluntariness [Title/Abstract] OR autonomy[Title/Abstract] OR choice[Title/Abstract] OR decision-making[Title/Abstract]) AND (acceptance[Title/Abstract] OR adoption[Title/Abstract] OR usage[Title/Abstract] OR utilization[Title/Abstract] OR implementation[Title/Abstract]) AND (UK[Title/Abstract] OR United Kingdom[Title/Abstract] OR England[Title/Abstract] OR Northern Ireland[Title/Abstract] OR Scotland[Title/Abstract] OR Wales[Title/Abstract])

Experience:

((Nurs*[Title/Abstract]) AND (technology[Title/Abstract] OR digital[Title/Abstract] OR electronic health record[Title/Abstract] OR EHR[Title/Abstract] OR app[Title/Abstract] OR devices[Title/Abstract])) AND (experience[Title/Abstract] OR usability[Title/Abstract] OR satisfaction[Title/Abstract] OR perception[Title/Abstract] OR opinion[Title/Abstract]) AND (UK[Title/Abstract] OR United Kingdom[Title/Abstract] OR England[Title/Abstract] OR Northern Ireland[Title/Abstract] OR Scotland[Title/Abstract] OR Wales[Title/Abstract])