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# An analysis of nurses' lived experience with digital health technologies in practice

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**Background and Purpose:** In the healthcare field, technological innovations have been introduced which are referred to as digital health technologies (DHTs). As digital technologies continue to impact the nursing profession on a global scale, nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare sphere. Whilst the benefits of DHTs have been empirically proven, usability problems, often encountered with usage, can be frustrating to both healthcare professionals and patients compared to other industries. The aim of this qualitative study was to understand, analyse and assess nurses' lived experiences of using DHTs as part of their work practices.
**Methods:** The study employed an interpretive stance and a qualitative phenomenological approach to explore the lived experiences of experienced nurses presently using DHTs in practice. In-depth interviews and observation were used to collect data from nurses in two public hospitals in Cape Town. A thematic analysis was used to organise and analyse the data acquired from the participants. The Normalization Process Theory (NPT) served as a theoretical lens to interpret the findings of this study. Purposive sampling was used to identify participants.
**Results:** Nurses, as end-users, have found DHTs to be relevant to their work practices and compatible with their existing work practices. It was found that, through the use of technology, nurses' tasks have become easier and more time-efficient, and as a result, nursing quality is improved.
**Conclusions:** Findings indicate that DHTs have been fully embedded into their daily work activities as patient care is optimised. Nurses positively appreciate technologies, to the extent that they cannot do their work without DHTs, and this is substantiated by their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill.

**Keywords:** nurse, digital health, digital health technology, lived experience, normalisation process theory.

## 1 Introduction

In the healthcare field, technological innovations have been introduced, which are referred to as digital health technologies (DHTs). As digital technologies continue to impact the nursing profession on a global scale, nurses are increasingly required to use various digital health technologies when providing direct care across the healthcare sphere. Several information and communication technology (ICT) systems are used in healthcare organisations to serve physicians and other healthcare professionals in their daily work with patient treatment services. These systems describe a broad range of applications, from the widely used computerised physician order entry (CPOE) systems to modern speech recognition technologies and mobile applications, diagnostic and imaging, clinician decision support and electronic prescribing technologies, a variety of patient monitoring systems using sensor network technology, and electronic health records (EHR) [1] [2] [3].

Digital health, or the use of digital technologies for health, has become a prominent field of practice when it comes to employing routine and innovative forms of information and communications technology (ICT) to address health needs. Rooted in e-Health, the term digital health is defined as "the use of information and communications technology in support of health and health-related fields" [4]. Mobile health

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(mHealth), a subset of eHealth, is defined as "the use of mobile wireless technologies for health" [4]). More recently, the term digital health was introduced as "a broad umbrella term encompassing eHealth (which includes mHealth), as well as emerging areas, such as the use of advanced computing sciences in 'big data', genomics and artificial intelligence" [4].

Studies have shown that implemented digital health technologies (DHTs) are essential, and the general consensus within and across the scientific research space is that they have the potential to improve patient safety and quality of care and reduce the cost of healthcare [5] [6] [7] [8]. Although the benefits of DHTs have been empirically proven, usability problems, often encountered with usage, can be frustrating to both healthcare professionals and patients compared to other industries [9] [10][11]. A number of challenges seem to recurrently hamper the effective use of DHTs, especially in the context of this study – Cape Town, South Africa. The implementation and use of DHTs have particularly been below par given that an e-Health strategy has been developed since 2012.

Furthermore, as the proliferation of ICTs has taken over healthcare organisations globally, information sharing and retrieval have become easier, with greater reliance on computers. A number of studies indicate that nurses, therefore, are not exempted from learning and using technology, and easy and quick access to information is crucial for effective nursing today [12] [13] [14] [15]. An important aspect of nursing and the nursing process is the management of patient information since the timeous exchange of relevant information of a patient is essential to ensure quality of care. Critical patient information is conveyed in a variety of forms, for example, through the DHTs such as the electronic health record, healthcare decision support systems, referral co-ordination, prescription and medication management, laboratory and diagnosis management.

Because the nursing profession has been influenced by the influx of DHTs, research indicates that nursing and technology are inextricably linked [16]. Healthcare in intensive care settings is more complex, as DHTs like ventilators, infusion pumps, monitors, and dialysis machines need to be carefully managed. *Technology* is regarded as items, machinery and equipment which are connected to knowledge and management to maximise efficiency. The authors further reiterate that it is not just the equipment per se, but rather, knowing how to use it and being able to integrate it into nursing care [10].

In most hospitals, intensive care units (ICUs) in particular, are highly technological environments. Patients in ICUs require specific technical nursing activities, such as attaching patients to life support equipment, and 24-hour supporting, treating and monitoring of patients' vital signs. Whilst attending to these activities, nurses are also required to attend to the physical as well as psychosocial needs of patients and their families [17]. It is therefore imperative for nurses to have the required technical skills as it forms an integral part of the caring process. Technology in an ICU also includes the use of medical-technical equipment. *Medical-technical equipment* refers to "equipment that will detect, prevent, monitor, treat, compensate for injury and disability or alleviate disease" [10]. Nurses working in ICUs, therefore, perform much of their work through the use of medical-technical equipment.

From the aforementioned, it is clear that, as proficiency in the use of DHTs is essential in today's nursing care, the advantages of using DHTs in the nursing profession are limitless. It is therefore imperative for nurses to improve their competencies [18] [19] [20] [21]. Nurses must continuously utilise technology as a means to access and manage records and to provide care via electronic means such as e-medicine and telehealth platforms. These digital technologies offer a significant opportunity to improve, enhance and transform healthcare [20]. However, to take advantage of these opportunities, nurses need to be competent; in other words, they need to possess the requisite knowledge, skills and resources to use technology and integrate it into their daily working activities.

Thus, due to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work processes. Hence, nurses' acceptance of DHTs and their lived experiences play a significant role in public healthcare institutions. However, scientific research that adequately explores lived experiences of nurses using DHTs is limited, especially in the context of this investigation – Cape Town, South Africa. It is vitally important that policymakers, administrators and managers work together with nurses to ensure that access to technologies which support

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good practice, as well as the work activities of nurses, is not compromised by practices that do not take into consideration the needs of nurses and their patients [18]. Moreover, a lack of inclusion of nurses not only negatively impacts the quality of care that patients receive, but also the overall efficiency of the healthcare system [22] [23][24]. Therefore, failure to include nurses in the design and development of new technologies will not only negatively impact the quality of care that patients receive, but also impacts the morale of nurses.

### 1.1 Problem statement

When considering the lived experiences of using DHTs in practice, the perspectives of nurses have received insufficient attention [18] [25][26]. Consequently, the literature suggests that there is limited information on the experiences of nurses regarding the use of DHTs in healthcare in sub-Saharan Africa (including South Africa) to guide future use thereof, particularly in view of the current influx of ICT into the region [27] [28]. With little or no information with regards to acceptability and usability of DHTs from nurses (the dominant group of end-users in a clinical setting), research is needed to begin to fill this gap in knowledge. It can thus be argued that, owing to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work processes. Whilst the literature supports that these technologies have great benefits, the impact on nurses and their workflow is not well known.

### 1.2 The objective of the research paper is the following

To ascertain how nurses make sense of the work practices as DHTs influence their daily work activities, and to accomplish the objective of this research paper, the study sought to answer the following research question and sub-questions:

Research Question:
How do nurses experience their work practices influenced by DHTs?

This question is based on the lived experience of the nurse who uses DHTs in the nursing care process when providing care to patients in a particular situation.

Sub-questions:
How are DHTs incorporated into nurses' work activities?
For what purposes are DHTs used by nurses?
What are the perceptions and experiences of nurses in the use of DHTs?

## 2 Research Methodology

**Research Design:** Since this research project was aimed at studying social actors (nurses and administrators) in their natural environment and focused on understanding the world from their point of view, the researcher has adopted an interpretive stance. The study sought to draw from the concepts of the normalisation process theory (NPT) as a theoretical lens to analyse how new technological innovation can be embedded into existing routine nursing practices rather than build a new theory. With this research study being qualitative in nature, interpretative phenomenology was an ideal methodology to use, mainly since this study focused on how individuals make sense of their DHTs used as part of their daily work activities. This interpretive phenomenological approach has helped to achieve the aim of this study and to answer the research question and sub-questions.

An interpretive study of nurses as end-users of DHTs has thus yielded important information about barriers, frustrations, needs, and preferences of nursing staff. Interpretive research with qualitative interviews was considered to be the most appropriate starting point, as it has provided access to nurses' subjective perceptions of DHTs. The data gained from the study was also valuable in determining nurse users' specific needs and their preferences for modifications to the DHTs being used.

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**The sampling method used:** the researcher used non-probability sampling via purposeful sampling to identify and select end-users who use DHTs as part of their daily work activities. This technique assisted the researcher in identifying a sample size that would provide in-depth information which is aligned with the research objectives of this study. A purposive sampling strategy is most commonly used in phenomenological research because it allows the researcher to select participants with rich knowledge of the phenomenon and is thus appropriate for an interpretive phenomenological study [26] [29].

**Inclusion criteria for the participants:** All ethical considerations were observed throughout the course of this research project. Ethical clearance was obtained from the Institution's Faculty of Health and Wellness Ethics Committee, as well as from the Faculty of Informatics and Design Ethics Committee. Thereafter, permissions were obtained from the Western Cape Department of Health to conduct the research within the selected tertiary and district hospitals. Participants' views were respected, and participants were given an option not to respond if they so choose. All personal data of participants gathered during the research, as well as their responses, were treated as confidential. It was made clear to participants that they were under no obligation to participate and may choose to withdraw from the study or refuse to answer any questions of any type, without suffering any consequences.

Two hospitals (one tertiary hospital and one district hospital) in the Western Cape were earmarked for selecting participants and data collection. A total of 22 participants (14 from Hospital A and 8 from Hospital B ) were purposefully selected and interviewed until saturation was reached. A variety of criteria was applied during the selection of participants, including the level of education, role, profession, job position/rank, work experience and station. Moreover, participants were selected according to age (>18 years) and the number of years of experience as a registered nurse The age distribution of this category of participants ranged between 31-60 years, with 50% falling in the 31-40 age bracket, while 41-50 and 51-60 groups constituted 25% each. At Hospital A, a total of 14 participants responded positively, indicating a willingness to participate. The participants interviewed comprised four nurses and two nurse managers from the General ICU, six nurses from ICU and two nurse managers from the Cardiac ICU. At Hospital B, seven nurses and the operations manager of the Emergency Unit were interviewed. The researcher specifically chose to investigate the work activities of registered nurses and nurse managers who actively use technology as part of their daily work activities.

**Data Collection:** The major data collection methods associated with an interpretive phenomenological study were in-depth interviews and observation. The sources of data collection comprised two categories, namely secondary data (the literature review) and primary data (from interviews with participants engaged in the delivery of healthcare). The interviews enabled the researcher to obtain a large volume of subjective data, which was then interpreted to gain in-depth information as understood and interpreted from the participants' points of view. In addition to interviews, observation was used to supplement the primary data gathered from interviews.

Observation forms were designed and relied on to capture events unfolding before the interviews. This assisted the researcher in taking field notes whilst observing participants in their environments during the study. The researcher could clearly observe participants, which assisted in gaining deeper insights into the phenomenon being studied. The researcher was able to observe the interactions between the various stakeholders, as well as the types of DHTs that were being used.

The interview instrument was developed based on a review of the literature, the research questions and also the normalisation process theory (NPT) as a guideline. During the interview sessions at both hospitals, the researcher endeavoured to refrain from asking leading questions and, instead, allowed the participants to narrate their experiences freely. During the interview, follow-up questions were posed. For example, the researcher would ask: Could you give me an example? How or what do you mean? Could you explain in a bit more detail? How did you feel about that? Can you describe that in more detail? The interviews were characterised by openness and flexibility, and the results of this study can attest to the fruitfulness of a descriptive method. Interviews were digitally recorded and transcribed verbatim by the researcher. Each interview was transcribed, compared with written notes and observations, and then saved, and participants

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were anonymised by being assigned a particular code. Each transcript was saved under this unique code. Participants were given the opportunity to review transcripts of the interview to clarify, revise or delete any portions thereof if they wished to do so.

**Data Analysis:** Two types of data analysis were performed for this study, namely a theoretical analysis using the Normalisation Process Theory (NPT) as an analytical lens and a thematic analysis of the data collected. The NPT has played a significant role in this qualitative research project as it has assisted in the research design, sampling and data collection. Furthermore, it has helped to inform, guide and structure the research focus and questions. Each construct was used to answer the main research questions and interpret the subsequent findings of this study. The normalisation process theory (NPT) served as a theoretical lens to interpret the findings of this research project, as it provided a conceptual framework that served to explain the processes whereby new health technologies and other complex interventions can be routinely embedded (operationalised) into everyday work, and integrated (sustained) in practice. Furthermore, it has served to elaborate on how new technological innovation can be embedded into existing practices – in line with the research problem of this study. Each recorded interview was transcribed verbatim, and the researcher spent much time reading and re-reading each transcript carefully.

The second analysis of the qualitative data obtained through interviews and observations, which include perceptions, attitudes, beliefs and opinions of participants regarding the phenomenon of this study, was undertaken using a thematic analysis. The semi-structured interviews were recorded, and the researcher listened and re-listened intensely to the recordings of the interviews, whereafter, recorded interviews were transcribed from audio to verbatim text. The researcher then examined the raw textual data line by line in an attempt to identify distinct events, incidents, ideas, actions, perceptions and interactions of relevance that are coded as concepts. A coding process was applied whereby the words or phrases were assigned descriptive codes. The researcher made use of descriptive codes to tag the emerging attributes, viz., keywords or phrases, as it relates to the issue that is being investigated and, thereafter, to categorise the themes. From the coding process, ten major themes emerged: 1) decision-making, 2) adapting to change, 3) DHT use, 4) DHT access, 5) DHT development, 6) information, 7) nursing administration, 8) patient care, 9) training and 10) workarounds.

## 3 Results

The NPT has played a significant role in this qualitative research project as it has assisted in the research design, sampling and data collection. Furthermore, it has helped to inform, guide and structure the research focus and questions. Each construct, namely, Coherence, Cognitive Participation, Collective Action and Reflexive Monitoring, was used to answer the main research questions and interpret the subsequent findings. It was essential to have a good comprehension of the NPT constructs to use them when analysing the data. Each core construct was interpreted in terms of the explanation of its associated NPT constructs. After the explanations) for the core NPT were interpreted, the NPT constructs were mapped to the interview questions (IQ), and explanations were formulated [30]. The table below summarises the results of the NPT analysis.

**Table 1: Key findings of NPT analysis**

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| **COHERENCE** is the sense-making work that people do individually and collectively when they are faced with the problem of operationalising some set of practices. [Sub-constructs: differentiation, communal specification, individual specification and internalisation.] |
| **Key finding: Participants have a sense of purpose; they have a deep understanding of the DHTs how they fit into their overall goals and activities, and how these technologies impact their work practices.** |

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| **COGNITIVE PARTICIPATION** is the relational work that people do to build and sustain a community of practice around a new technology or complex intervention. [Sub-constructs: initiation, enrolment, legitimisation and activation.]<br><br>**Key finding: There appears to be buy-in from participants to the extent that participants feel the need to invest time and energy into learning new technologies. However, a number of barriers were uncovered which hamper participants' ability to sustain their involvement in the use of DHTs** |
| **COLLECTIVE ACTION** is the operational work that people do to enact a set of practices, whether these represent a new technology or complex healthcare intervention. [Sub-constructs: interactional workability, relational integration, skill set workability and contextual integration.]<br><br>**Key finding: Participants have expressed confidence in the system and positively appreciate technology. The many benefits derived from DHTs enhance patient care and facilitate access to and the management of information. Overall, technology makes their work easier.** |
| **REFLEXIVE MONITORING** is the appraisal work that people do to assess and understand the ways that a new set of practices affect them and others around them. [Sub-constructs: systemisation, communal appraisal, individual appraisal and reconfiguration.]<br><br>**Key finding: Participants are receptive to the use of DHTs and do not see it as a barrier between them and their patients. However, concern was expressed at the non-inclusion of nurses in the design and development of DHTs, and the fact that there is no channel for nurses to appraise the DHTs used as part of their daily work practices.** |

Furthermore, an analysis of the qualitative data obtained through interviews and observations, and which include perceptions, attitudes, beliefs and opinions of participants regarding the phenomenon of this study, was undertaken by means of a thematic analysis. From the coding process, ten themes emerged, namely: 1) decision-making, 2) adapting to change, 3) DHT use, 4) DHT access, 5) DHT development, 6) information, 7) nursing administration, 8) patient care, 9) training, and 10) workarounds. The themes of this study emerged from the interviews conducted with 22 participants (17 registered nurses, four nurse managers and one operations manager) regarding the use of DHTs as part of their daily work activities. These individuals willingly shared their valuable time and experience with the researcher during their interviews and observation sessions. The accounts of their experiences were an integral and essential part of this research project to gain a deeper understanding of their lived experience with DHTs (refer to Table 2 below).

**Table 2: Key findings of thematic analysis**

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| **Decision-making** | Nurses often use their knowledge, intuition and experience to make decisions based on their awareness of a particular situation. Therefore, given the nature of the DHTs available to nurses in an ICU and EC setting, these technologies facilitate nurses in their decision-making and optimises patient care. |
| **Adapting to change** | Reactions reflected a high degree of awareness of the immense benefits of DHTs and how it optimises the work practices of participants. Whilst there was initial resistance, predominantly due to fear of the unknown, many fears have been allayed once participants came to appreciate the value of DHTs. |
| **DHT use** | Participants have stated that DNTs do not hinder the nurse-patient relationship. Whilst there is consensus on the benefits of using DHTs as part of their work activities, participants have expressed concrete ideas on how to further optimize their work practices through the use of DHTs, for example, having their own login credentials to look up patients' results, having their own email addresses, and having an opportunity to provide feedback on DHTs that are currently being used. It was noted that very few nurses have their own login credentials. |

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| **DHT access** | The participants notably highlighted the following barriers that hampered their DHT use and access: insufficient number of computers, the limited time assigned to the triage process, a lack of login credentials, limited training opportunities, the long response time when technologies need repair, poor connectivity, occasional patient resistance to the use of technology, and the (sometimes negative) effect of DHTs on the nurse-patient relationship, and the need for electronic reporting as opposed to manual reporting. |
| **DHT development & support** | Whilst the importance and relevance of nurses' participation in the process of technology development are`` frequently stressed by developers, scientists and funding bodies, their actual participation has been described as negligible. Furthermore, nurses often fail to identify and communicate their needs and ideas for application scenarios or improvements to DHT in everyday care practice. Responses were gathered from nurse managers at Hospital A and the Operations Manager at Hospital B. As end-users of DHTs, it is imperative that nurses be included in the process of developing new technologies. |
| **Information** | The results indicate unanimous agreement amongst participants that technology has become an integral part of patient care, particularly in the ICU, because it saves time, it facilitates the monitoring of patients, improves patient administration and access to patient information. Some of the benefits of information availability are: improved recordkeeping, easy access to and flow of information, improved productivity as DHTs reduce time spent with patients. |
| **Nursing administration** | Since DHTs are incorporated into the daily work activities of nurses, there is notable improvement in nursing administration, as well as recordkeeping. Nursing administration is optimised because doctors, nurses and clerks have access to the system. |
| **Patient care** | The positive impact of technology, particularly where the technology improved nurse-patient interaction, is evident from the participants' responses. The use of technological devices provides convenience, particularly cardiac monitors have positive benefits by monitoring the patient's vital signs continuously and transmitting data in real-time as well as remote monitoring. |
| **Training** | Nurses have overwhelmingly indicated that their training needs were not assessed prior to the introduction of any new technology. Whilst nurses positively appreciate technology, the lack of training is a significant barrier that seems to hinder their ability to derive maximum benefit and pass such benefit on to their patients. Training is in the form of peer-to-peer or learning-by-doing, which is not ideal. Concerning the organisation of training programmes, the results showed they are organised at a moderate frequency; however, nurses are not keen to capitalise on it due to their situated practice. There are often staff shortages, which deters them from attending formal training programmes. Participants also cited a lack of time, family obligations, and lack of support from both the workplace and managers. |
| **Workarounds** | It is clear from the data that technology has made work easier and improved workflow and productivity. Nurses see technologies such as ventilators and cardiac monitors as a means of communication and guide them to what the needs of the patients are. Nurses feel that technology has a positive impact on the nurse-patient relationship, and whilst they are in agreement that technology does not negatively affect the nurse-patient relationship, they nevertheless do not fully trust technology and, as a result, have experienced technical problems with some of the DHTs. This has led them to resort to initiating workarounds to provide the best care for their patients. This means that, where necessary, nurses would resort to their foundational practices, for example, physically taking a patient's blood pressure or physically looking at the clinical picture of the patient instead of accepting the outcome of the cardiac monitor. |

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When answering the research question and sub-questions, the results are presented in Table 3 below.

In an effort to determine how DHTs are incorporated into nurses' work activities, it was found that, as the end-user using digital health technologies in practice in the situational context of work, nurses have found DHTs to be relevant to their work and compatible with their existing work practices. This is evident from the results as it fits into their existing roles and skills, thereby enabling them to provide better care and service to their patients. Similarly, findings show that technology has become an integral part of patient care. From this, it is evident that DHTs have been fully incorporated into their daily work activities as patient care is enhanced.

> *"It is very relevant for us and very accurate because it can give you the time of arrival of the patient, the time awaited in triage. What time the patient was triaged, what time the patient was seen by the doctor and the waiting period of the patient is captured. When the patient is discharged, it also shows that the patient was in EC and now he or she is discharged. If the patient goes to another ward or an overnight ward, it also tells you that this patient is no longer in EC but has moved to another ward. It is very accurate." (Participant MP03)*

In an effort to determine the purpose for which nurses use DHTs, it was found that nurses have a highly positive appreciation for the DHTs used as part of their daily work practices because these technologies enhance decision-making and provide critical information to enable them to prioritise patient care.

> *It can accurately predict the severity of the patient's condition. Sometimes as nurses you can't always tell how sick the patient is. However, with this technology, if a patient is rated orange, it can tell you that the patient has chest pain and you can immediately do an ECG. (Participant MP02)*

The use of DHTs as part of nurses' daily work activities has drastically improved patient care. With technology, nurses' tasks have become easier and more time-efficient, and nursing quality has improved.

> *"So we stand in one place and can observe over 20 patients' vital signs at once and act immediately when there is a problem." (Participant TB01)*
> *"The service delivery is quicker, and the waiting time is shorter. I can also see on the doctor's computer because we are linked." (Participant MP05)*

When determining the perceptions and experiences of nurses in the use of DHTs, the findings indicate that DHTs have been fully incorporated into their daily work activities as patient care is optimised. Nurses, as end-users, have found DHTs to be relevant to their work practices and compatible with their existing work practices. It was found that, through the use of technology, nurses' tasks have become easier and more time-efficient, and as a result, nursing quality is improved.

> *We don't have to write as before, you enter electronically. Sometimes papers get lost or misplaced, then you have to rewrite it. However, it is on the system, it improves productivity. It used to take 15 minutes to triage a patient, but now it is easy and takes less time. (Participant MP03)*

Nurses positively appreciate the DHTs; this is evident in their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill. The findings further indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs; as noted above, this is substantiated by their desire to learn new technology, not only to optimise patient care but to expand their knowledge and skill.

> *I would love to learn new technology. I need to know the patient's results. I often order x-rays, and I interpret the x-rays and blood results, and sometimes you need proper training. (Participant MP03)*

 

**Table 3: Research Question 1 answered.**

| **Research Question 1 (RQ1):**<br>**How do nurses experience their work practices influenced by DHTs. This question is based on the lived experience of the nurse who uses DHT in the nursing care process when providing care to patients in a particular situation.** | |
|---|---|
| **Sub-Questions** | **Objective** |
| RSQ1: How are DHTs incorporated into nurses' work activities | To determine how DHTs influence nurses' work activities. |
| RSQ2: For what purposes are DHTs used by nurses? | To ascertain why nurses use DHTs. |
| RSQ3: What are the perceptions and experiences of nurses in the use of DHTs? | To determine how nurses perceive and experience the use of DHTs in practice. |
| **RESEARCH QUESTION 1 ANSWERED:**<br>*The findings indicate that DHTs have been fully incorporated/embedded into their daily work activities as patient care is optimised. As end users, nurses have found DHTs relevant to their work practices and compatible with their existing work practices. It was found that, through the use of technology, the nurses' tasks have become easier and more time-efficient, and, as a result, nursing quality is improved. Nurses positively appreciate the DHTs, and this is evident in their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill. The findings further indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs. This is substantiated by their desire to learn new technology, not only to optimize patient care but to augment their knowledge and skill.* | |

## 4 Discussion on results

Analysing the data by firstly using the NPT as an analytical lens and secondly by means of a thematic analysis has afforded the researcher a deep understanding and insight of and into the lived experiences of nurses as they experience DHTs as part of their daily work activities.

The evidence overwhelmingly suggests that DHTs have permeated nurses' lives and, as such, have become embedded into their everyday lives. It is further evident that nurses' work activities are still largely paper-based with a combination of support provided by various digital health technologies. Whilst clinical notes and observations are largely paper-based (and later scanned), electronic systems are used to monitor patients, perform triage, register patients electronically, and perform a variety of administrative duties.

Analysing the data using the NPT as an analytical lens and by means of a thematic analysis has afforded the researcher a deep understanding of the lived experience of nurses as they experience and use DHTs as part of their daily work activities.

The ten themes which emanated from the analysis are a representation of the many ways whereby DHTs facilitate nurses' jobs. Whilst there is consensus that technology is positively received by participants and that the benefits are immense, a number of barriers have been identified that prevent participants from deriving maximum benefits from the DHTs being used. These barriers include nurses not having their own login credentials to look up patients' results, an insufficient number of computers, a lack of training, etc. Furthermore, this is exacerbated by the lack of inclusion of nurses in the development and implementation of new technologies.

When combining the results of the ten themes of the thematic analysis while also mapping it to the results derived from the NPT analysis, a number of conclusions can be drawn. Although similarities were considered, the mapping of each NPT sub-construct was not necessarily aligned with the data themes because the focus of this study was not on verifying the NPT theory but rather on using it as an additional theoretical lens during the analysis of the data.

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The first consideration was whether any findings from the NPT analysis do not have a similar finding from the thematic analysis. It is important to note that when the researcher analysed the data through the lens of the NPT, all four constructs, including sub-constructs, were used. Interestingly, whilst the researcher was investigating the applicability of the NPT in similar studies, the researcher found that most studies only used one construct, for example, Collective Action [31] [32].

When mapping the findings of the NPT to the thematic analysis, an important finding is that whilst the NPT serves as a conceptual framework to explain the processes whereby new health technologies and other complex interventions can be routinely embedded or operationalised into everyday work and subsequently sustained in practice, the NPT constructs only focus on the implementation of new health technologies and not on the design and development thereof. The NPT, therefore, does not make provision for the design and development of complex interventions. A possible reason could be that the framework was designed to be used from an end-user perspective and not from the perspective of the developer.

The next consideration is whether there are findings from the thematic analysis that were not present from the NPT analysis (refer to Table 2). The theme of decision-making, when mapped to the constructs of the NPT, could only be linked to the construct, Collective Action. This construct served to ascertain whether DHTs promote or impede the work of nurses, whether it is compatible with work practices and the impact thereof on the division of labour. In particular, it relates to the sub-construct of skill set workability, which refers to the degree to which the technology fits into existing work practices, skill sets and the nurses' perceived work role. Furthermore, it enhances their existing roles and skills, thereby enabling them to provide better care and service to their patients. However, the construct does not explicitly focus on the decision-making aspect of nurses' jobs.

The next consideration is to determine which findings from both the thematic and NPT analysis are similar. The theme, DHT use, could be mapped to all four NPT constructs. This is significant because key findings from the data indicate that there is consensus amongst the participants regarding the benefits of using DHTs as part of nurses' daily work activities. Furthermore, since DHTs have become an integral part of their lives, and many nurses have become very skilled in the use of DHTs, they have expressed concrete ideas on how some DHTs could be adapted to optimise their work. From this, the researcher can deduce that DHTs have been embedded into the work practices of nurses. This is also a clear indication that DHT could be further optimised if nurses' input were to be considered prior to the implementation thereof.

In an effort to ascertain how nurses make sense of the work practices as DHTs influence their daily work activities, the findings indicate that DHTs have been fully incorporated into their daily work activities as patient care is optimised. Nurses, as end-users, have found DHTs to be relevant to their work practices and compatible with their existing work practices. It can thus be concluded that, through the use of technology, nurses' tasks have become easier and more time-efficient, and as a result, nursing quality is improved. Nurses positively appreciate the DHTs; this is evident in their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill. Despite a number of barriers, the findings further indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs; as noted above, this is substantiated by their desire to learn new technology, not only to optimise patient care but to enhance their knowledge and skill.

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None

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