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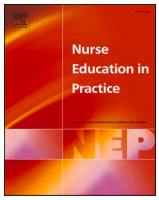

The use of smart glasses in nursing education: A scoping review

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ABSTRACT

Aim: The aim of this scoping review was to give an overview of the usability and feasibility of smart glasses in nursing education. In addition, this study will highlight nursing students' experiences of using smart glasses in learning situations.

Background: Healthcare is becoming increasingly complex and technological and so is nursing education. Technology enhanced learning aims to enhance the teaching-learning process through use of technology, for example through smart glasses.

Design and methods: A literature review using a scoping review methodology was conducted. Qualitative content analysis was performed to analyse data. 14 references were included in the analysis. References were found using the databases PubMed, SCOPUS and ERIC.

Results: The analysis resulted in three categories; (1) Situations in which smart glasses have been used in nursing education, (2) Learning experiences from using smart glasses in nursing education, and (3) User experiences from using smart glasses in nursing education. Smart glasses were used in different learning situations and were in general positively evaluated by nursing students. Although, drawbacks of using smart glasses were noted which could negatively effect student learning.

Conclusions: Smart glasses have been used in a variety of learning situations in nursing education and enabled new learning situations. Students found smart glasses beneficial for their learning and smart glasses motivated and engaged students in the learning situation. Although, this was both user- and situation dependent. Technical issues could cause students to lose focus and there is need for technical support to facilitate the learning curve. By learning from others' experiences unnecessary drawbacks can be avoided.

1. Introduction

Healthcare and nursing care is becoming increasingly complex and technological. Naturally, this is reflected in nursing education as well. Technology enhanced learning aims to enhance the teaching-learning process through use of technology (Bullock and de Jong, 2013). Smart glasses have been used both within healthcare (Dougherty and Badawy, 2017; Mitrasinovic et al., 2015; Romare and Skär, 2020; Wei et al., 2018; Zhang et al., 2023) and medical education with promising results (Brewer et al., 2016; Carrera et al., 2019; Datta et al., 2015; Knight et al., 2015; Lin et al., 2022; Wu et al., 2014). But what is known about the use of smart glasses in nursing education? This study will give an overview of the use of smart glasses in nursing education and highlight the nursing students' experiences.

2. Background

Nursing is a profession with great complexity and responsibility. The road to become an expert level nurse is long. Both education and experience are prerequisites to advance in proficiency level and meet the demands of the complex clinical practice (Benner, 1982). Higher education strives to help students acquire knowledge and skills required in their future profession. Learning can be promoted by a variety of learning activities. Often, several teaching concepts complement each other to promote student learning. One of these complements can be the use of technology (Elmgren and Henriksson, 2014). Technology enhanced learning is a term emphasising that technology should add to the learning process, not replace traditional learning. Technology should be seen as a tool to enhance learning and be an integrated part of the learning process (Bullock and de Jong, 2013). It is important that technology enhanced learning become driven by pedagogy with technology as a facilitator (Hammad et al., 2020).

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For technology to be adopted, both perceived usefulness and ease of use is known to be important (Holden and Karsh, 2010; Rosli and Saleh, 2022). In addition, learnability is an important influencing factor (Mendoza et al., 2010). Learnability is a concept often used within software engineering and is defined as "*degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use*" (§ 4.2.4.2, International Organization for Standardization, 2011). To be a part of technology enhanced learning, it is reasonable to assume that technology should be both easy to learn and easy to use, as well as being a useful facilitator for student learning. Although technology might offer potential, questions are raised whether there is a need for technology enhanced learning and whether it brings an actual benefit (Goodchild, 2018). Nevertheless, there is an increased use of technology in nursing education to engage students and encourage active learning. A vast majority of the students found technology useful in nursing education. Technology was seen as helpful and improved the learning experience (Williamson and Muckle, 2018). Different types of technology have been integrated in nursing education, such as learning management systems (Meum et al., 2021) and mobile devices (Lee et al., 2018). Lately, the Covid-19 pandemic have accelerated the use of technology in higher education (Rosli and Saleh, 2022).

One type of technology that can be used in education are smart glasses. Smart glasses are a technical device introduced on the market in early 2010 s. The term "smart glasses" were added as Medical Subject Heading (MeSH) in year 2020 and are defined as: "*Computerized eyewear with multiple technological applications for advanced computing and interoperability. Smart glasses are optimized to facilitate information and data access, capture, display, transfer, and manipulation*" (National Library of Medicine, n.d.). Further, several smart glass specific characteristics are outlined. For example, smart glasses are head-mounted and worn like eyeglasses. The user can interact with the smart glasses through input and sensors. The smart glasses are computerised with connectivity to other remote devices or services, such as the Internet. Information captured by the smart glasses can be forwarded to other connected devices. The wearer is not locked out from the surroundings and information from the smart glasses is projected in the users' field of view as a digital overlay (Zuidhof et al., 2021).

Smart glasses have been used in education (Ali et al., 2019; Al-Maroof et al., 2021; Kumar et al., 2018; Peterson et al., 2020), and teachers believes that smart glasses can have positive impact on both teaching and learning (Kazakou and Koutromanos, 2022). Different smart glass applications have been used in education, for example: capture video and images, telementoring, augmented reality, and voice to text (Kumar et al., 2018). Smart glasses have also been used in different healthcare settings (Dougherty and Badawy, 2017; Mitrasinovic et al., 2015; Romare and Skär, 2020; Wei et al., 2018; Zhang et al., 2023). Further, smart glasses have been used in medical education with promising results (Brewer et al., 2016; Carrera et al., 2019; Datta et al., 2015; Knight et al., 2015; Lin et al., 2022; Wu et al., 2014). It is suggested that augmented reality, for example through smart glasses, can promote student centred learning in nursing education (Mendez et al., 2020). This combined with the positive results from previous research about smart glasses in medical education might lead to the suggestion that smart glasses should be implemented in nursing education as well. However, before this suggestion can be made it is imperative to learn from findings presented in previous research. Therefore, the aim of this study is to give an overview of the usability and feasibility of smart glasses in nursing education. In addition, this study will highlight nursing students' experiences of using smart glasses in learning situations.

3. Methods

A scoping review methodology was chosen for this study. The methodological framework described by Arksey and O'Malley was used (Arksey and O'Malley, 2005). Scoping studies are recommended when the aim is to give an overview of a research area. The aim is proposed to be broad and a scoping study can include studies with different designs. A scoping study can show the volume and characteristics of research in a specific field. Further, a scoping study can identify research gaps and provide a summary of research findings (Arksey and O'Malley, 2005; Levac et al., 2010). To increase transparency, this study is reported according to the checklist: PRISMA Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018).

Step one was to identify the aim. The second step was to identify relevant references, answering the aim, to include in the study (Arksey and O'Malley, 2005). Three bibliographic databases were used, SCOPUS, PubMed and ERIC. SCOPUS comprises both technical as well as medical sources. PubMed covers mainly medical sources, while ERIC focus on education. This combination of databases was seen to provide possibilities to find views of smart glasses used in nursing education through different research traditions. Experienced librarians were consulted in the process of searching as suggested (Arksey and O'Malley, 2005).

Database searches followed the structure of Population, Exposure and Outcome (PEO). First, searches related to *population* was conducted. Different search terms related to education and nursing were used and combined in search blocks. Then searches related to the *exposure* was made. Different terms related to smart glasses, such as "smart glasses" and different brand names, was used and combined in one search block. Since a wide aim was chosen no specific searches were made regarding *outcome*. Given that smart glasses are fairly new, with MeSH term introduced in year 2020, searches were made in "all fields" to gain more comprehensive searches. Searching was an iterative process where search terms were added during the process as suggested (Arksey and O'Malley, 2005; Levac et al., 2010). Final search terms are presented in Supplemental Material 1. Database searches were made in February 2022, and the deadline for searching other sources were set to March 2022. Search results are presented in Supplemental Material 2. Additional references were found using, for example, research networks, reference lists and suggestion on similar articles during database searches (Supplemental Material 2). This is an indorsed approach in the scoping methodology (Arksey and O'Malley, 2005).

Primary sources of all types could be included, such as research articles and conference papers. Studies should be published or in press to be included, preprints were excluded. Research using all methodologies were accepted. To be included, references should be in English or Scandinavian languages. No limits regarding date were set since smart glasses are a relatively new technical device. Reviews were excluded, but their reference lists were screened. Grey literature can be included in a scoping review, although no such sources were found during the searches.

Step three was the selection. First, titles in the search results were screened to identify relevant references answering the study aim. If the title indicated a relevant reference the abstract was read. For some references methods sections were screened as well to make sure that they included nursing students and smart glasses. Full text articles were ordered and read before decision about inclusion was made (Arksey and O'Malley, 2005) (Fig. 1). No quality assessment was made since that is not recommended in a scoping study (Arksey and O'Malley, 2005).

25 references were read in full text and 14 were included. The next step, step four, was to chart data. This charting should include both general and specific information about the references (Arksey and O'Malley, 2005). Charting included advised information (Peters et al., 2020) and is presented in Supplemental Material 3. In the fifth step of the scoping methodology results were collated, summarised and reported (Arksey and O'Malley, 2005). This is known to be a challenging step that to some extent overlap charting of data. Using a qualitative content analysis approach to complement the charting can be beneficial (Levac et al., 2010). Accordingly, in this scoping study Graneheim's and

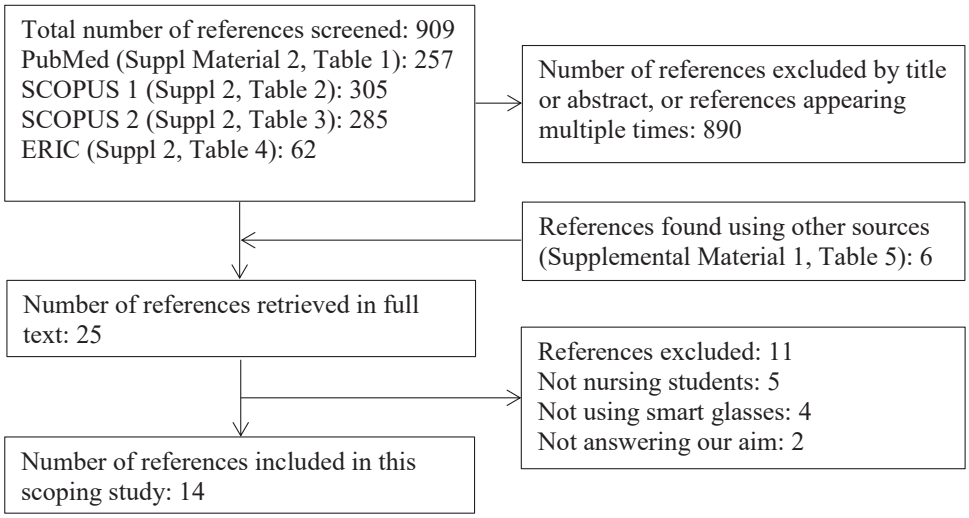

Fig. 1. Flow chart of identifying relevant references.

Lundman's description of qualitative content analysis was used (Graneheim and Lundman, 2004). During analysis, all meaning units answering the aim were marked and copied into a separate document. Meaning units were then continuously numbered, condensed if needed and labelled with a code. Codes were then organised in three categories. Each category was narratively described at a manifest level. The five steps of this scoping study was mainly conducted by the first author, but all steps were continuously discussed between both authors as suggested (Graneheim and Lundman, 2004; Levac et al., 2010).

4. Results

14 references published between year 2015–2021 were included in analysis. The references originated from USA (n=6), Korea (n=3), Australia (n=2), New Zealand (n=1), Germany (n=1), and United Kingdom (n=1). The references were published as; research articles (n=6), feature articles (n=2), conference papers (n=1), short paper (n=1), or no article type stated (n=4). Data was collected through questionaries (n=12) and/or observations/recordings (n=7). Further, data was recorded from simulation equipment (n=1). The number of participants in conducted studies was 10–99. Different smart glasses were used including Google Glasses (n=9), Microsoft HoloLens (n=2), Vuzix Glasses (n=2), and Camcorder Glasses (n=1). Six of the references were pilot studies. Charting of included references is presented in Supplemental Material 3.

Keywords are used to indicate the focus of the research. A variety of keywords (n=55) was used in the included references. Two references presented no keywords. Keywords occurring in at least two references (n=10) are presented in Fig. 2 to visualise the focus of included references.

The result of the analysis will be presented using the three categories as headings; (1) Situations in which smart glasses have been used in nursing education, (2) Learning experiences from using smart glasses in nursing education, and (3) User experiences from using smart glasses in nursing education.

4.1. Situations in which smart glasses have been used in nursing education

All included references described a specific learning situation where smart glasses had been used, see Fig. 3. Smart glasses were used in five different learning situations. Firstly, smart glasses were used to self-review or get feedback after practice. One example was to capture video of a simulation that could be reviewed afterwards (Forbes et al., 2016; Frederick and Van Gelderen, 2021; Marrocco et al., 2019; Schneidereith, 2015). Secondly, smart glasses were used to communicate with colleagues at a distance using voice and/or video calls. This could for example entail remote support (Byrne and Senk, 2017; Lee et al., 2021; Yoon et al., 2021). Thirdly, smart glasses were used to get additional information during simulation and practice. Examples of this was video of a patient actor to enhance simulations, or real-time feedback from CPR mannequin (Chaballout et al., 2016; Gruenerbl et al., 2018; Vaughn et al., 2016). Fourthly, smart glasses were used to provide holographic patients for visual assessment (Collins and Ditzel, 2021; Frost et al., 2020). Finally, smart glasses were used to get visual step by step instructions during self-practice (Kim et al., 2021; Kopetz et al., 2019). All learning situations were simulated, and none involved real patients or actual clinical practice.

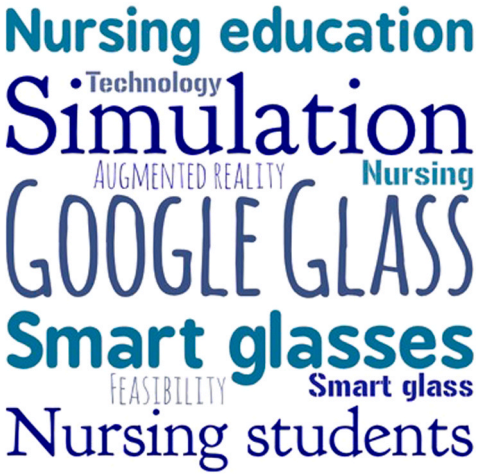

Fig. 2. Keywords occurring in at least two references, size indicates occurrence.

4.2. Students' learning experiences from using smart glasses in nursing education

Nine references addressed smart glasses' effect on learning experiences for nursing students (Chaballout et al., 2016; Collins and Ditzel, 2021; Forbes et al., 2016; Frederick and Van Gelderen, 2021; Frost et al., 2020; Kim et al., 2021; Lee et al., 2021; Marrocco et al., 2019; Vaughn et al., 2016). As indicated by the keywords presented in Fig. 2, student learning was not the focus for the included references, and some references only addressed the effect on student learning briefly.

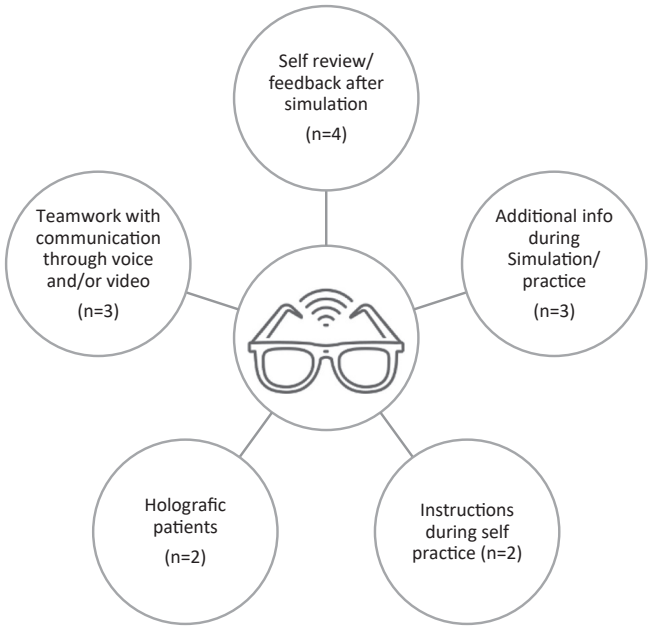

Fig. 3. Learning situations where smart glasses have been used. Glasses icon by Icons8.com.

In several references students stated that using smart glasses was beneficial to their learning (Collins and Ditzel, 2021; Frederick and Van Gelderen, 2021; Frost et al., 2020; Kim et al., 2021; Vaughn et al., 2016). Further, students found using smart glasses educational (Frost et al., 2020; Marrocco et al., 2019) and developing for clinical judgement (Frost et al., 2020; Vaughn et al., 2016). However, this finding was not unanimous (Forbes et al., 2016), and some students believed that using smart glasses was not more effective than lecture based education (Kim et al., 2021).

Using smart glasses provided additional possibility for reflection (Forbes et al., 2016; Frederick and Van Gelderen, 2021; Frost et al., 2020; Marrocco et al., 2019; Schneidereith, 2015). Students found areas where they needed to improve by reviewing their own performance through video recorded by smart glasses (Frederick and Van Gelderen, 2021; Marrocco et al., 2019). Some students appreciated learning from watching peers (Frost et al., 2020), or seeing a situation as it was seen by someone else (captured by smart glasses), while others did not (Frederick and Van Gelderen, 2021). Further, video recorded by smart glasses provided teachers the opportunity to review and evaluate students' performance during simulation in order to provide valuable feedback for further improvement (Schneidereith, 2015).

Also, the possibility to closely examine a holographic patient without causing discomfort was welcomed (Collins and Ditzel, 2021; Frost et al., 2020). This was related to smart glasses' ability to create a safe learning environment (Collins and Ditzel, 2021; Frost et al., 2020; Vaughn et al., 2016).

> *"Being able to see a real life presentation of a health problem, while learning what do to in this situation, in a safe environment on a mannequin is immensely beneficial"* (Vaughn et al., 2016, p. 403)

Several aspects known to be valuable to student learning was mentioned by students in included references. Using smart glasses in nursing education were noted to engage students in learning (Frost et al., 2020; Kim et al., 2021; Lee et al., 2021). Students stated that using smart glasses was a motivational (Forbes et al., 2016; Vaughn et al., 2016), memorable (Frost et al., 2020; Kim et al., 2021), interesting and meaningful learning experience (Kim et al., 2021). Students also reported high scores on self-confidence in learning using smart glasses (Chaballout et al., 2016).

> "*visualising a scenario helps creating longer lasting impression in minds of a learner*" (Frost et al., 2020, p. 217)

4.3. User experiences from using smart glasses in nursing education

Smart glasses were stated to be novel in nursing education in all included references. Although, only one reference (Lee et al., 2021) clearly stated the included students did not have any prior experiences of smart glass use. Smart glasses were found to facilitate a variety of learning situations (Byrne and Senk, 2017; Lee et al., 2021; Vaughn et al., 2016), for example providing visualisation of patients (Collins and Ditzel, 2021; Frost et al., 2020) and making the situation more realistic (Collins and Ditzel, 2021; Frost et al., 2020; Vaughn et al., 2016). Additional information during simulation and practice was appreciated (Byrne and Senk, 2017; Kim et al., 2021; Vaughn et al., 2016). Information provided by smart glasses during simulations increased students understanding regarding the patient's situation (Chaballout et al., 2016; Collins and Ditzel, 2021).

> "*It made the scenario much easier to understand compared to just a written one*" (Collins and Ditzel, 2021, p. 150).

Further, reminders presented in smart glasses were valued (Kopetz et al., 2019), as well as improved communication (Byrne and Senk, 2017). Students enjoyed using smart glasses in different learning situations (Chaballout et al., 2016; Collins and Ditzel, 2021; Kim et al., 2021; Kopetz et al., 2019; Lee et al., 2021; Marrocco et al., 2019; Vaughn et al., 2016), and found smart glasses easy to use (Byrne and Senk, 2017; Kim et al., 2021).

> "*It was quite straightforward, I figured out how it works right away*" (Kim et al., 2021, p. 8)

It was individual how the students managed to handle smart glasses (Byrne and Senk, 2017; Kim et al., 2021) but all students managed to complete the assignments (Byrne and Senk, 2017). Students faced a learning curve using smart glasses (Chaballout et al., 2016; Kim et al., 2021; Lee et al., 2021; Vaughn et al., 2016). Students declared that an introduction was mandatory (Chaballout et al., 2016; Kim et al., 2021) and the need for technical support was high (Lee et al., 2021). Some students did not see significant benefits using smart glasses and would not like to use them with actual patients. Further, students thought that smart glasses could interfere with interaction with actual patients (Kopetz et al., 2019).

Improvement in student performance were seen after a smart glass intervention (Forbes et al., 2016; Gruenerbl et al., 2018; Kim et al., 2021; Kopetz et al., 2019), although not for all students (Forbes et al., 2016). Students felt more confident after practicing nursing care using smart glasses (Kopetz et al., 2019) and many students recommended continued use of smart glasses in nursing education (Collins and Ditzel, 2021; Frederick and Van Gelderen, 2021; Frost et al., 2020; Kim et al., 2021; Lee et al., 2021; Vaughn et al., 2016).

Some students found smart glasses comfortable (Kopetz et al., 2019) and the hands-free feature was appreciated (Byrne and Senk, 2017; Frederick and Van Gelderen, 2021). Nevertheless, it was noted that improvement of the concept was needed (Lee et al., 2021; Yoon et al., 2021). Smart glasses were found to cause headache, slight dizziness (Frost et al., 2020) and tired eyes, as well as increased cognitive load (Lee et al., 2021). Further, smart glasses fogged easily while wearing mask (Kim et al., 2021) and discomfort was noted by users wearing prescript glasses (Kim et al., 2021; Lee et al., 2021). Another issue mentioned was the inability to interact with the holographic patients (Collins and Ditzel, 2021). Although, the main drawback noted was that smart glasses could be distracting (Byrne and Senk, 2017; Chaballout et al., 2016; Frederick and Van Gelderen, 2021; Frost et al., 2020; Kopetz et al., 2019; Marrocco et al., 2019; Vaughn et al., 2016).

"*It was distracting… The reason why is because my eyes have to look at two things*" (Vaughn et al., 2016, p. 404)

Several issues related to smart glass technology were noted. The main problem reported was related to connectivity (Chaballout et al., 2016; Lee et al., 2021; Schneidereith, 2015; Yoon et al., 2021). Further, some users expressed satisfaction with the screen (Lee et al., 2021; Yoon et al., 2021) except for motion blur (Yoon et al., 2021) while others had a hard time to see the presented information (Byrne and Senk, 2017; Kim et al., 2021). The field of vision for video captured by smart glasses was experienced as too narrow (Forbes et al., 2016; Lee et al., 2021; Schneidereith, 2015; Yoon et al., 2021). Also, technical issues with loss of picture were noted (Collins and Ditzel, 2021).

"tech isn't perfect, runs into a few problems" (Collins and Ditzel, 2021, p. 150)

Finally, heat generation (Chaballout et al., 2016; Frederick and Van Gelderen, 2021; Kim et al., 2021), battery life (Chaballout et al., 2016) and the audio system were noted as drawbacks (Byrne and Senk, 2017; Yoon et al., 2021). Smart glasses were also perceived as heavy (Frederick and Van Gelderen, 2021; Frost et al., 2020; Kim et al., 2021).

5. Discussion

The aim of this study was to give an overview of the usability and feasibility of smart glasses in nursing education. In addition, the aim was to highlight nursing students' experiences of using smart glasses in learning situations.

5.1. Discussion of results

The results show that smart glasses have been used in a variety of learning situations in nursing education and that the smart glass technology provided utility for new learning situations. Students found smart glasses beneficial for their learning and made them motivated and engaged in the learning situation. Although, this was both user- and situation dependent. Drawbacks of smart glass use were noted that might effect both the learning experience and the user experience.

The results show that students found smart glasses to be an engaging and motivating part of the learning experience. This result is in line with a recent meta-analysis showing that wearables, including smart glasses, can have positive effect on students' motivation (Havard and Podsiad, 2020). Motivation has also been linked to learnability enhancement (Hafsa et al., 2021). Further, it has been shown that intrinsic motivation can predict engagement in technology enhanced learning. Importantly, that study also provides insights about that engagement in technology enhanced learning, not usage, can predict academic achievement (Dunn and Kennedy, 2019). Other researchers show that perceived psychological benefits (i.e. positive feelings) from using technology in education could positively impact both active learning and class learning experience (Zhuang and Xiao, 2018). Even if the aforementioned studies did not include technology enhanced learning by means of smart glasses, the results are of interest for our research as well. Features like engagement, motivation and active learning is known to promote student learning (Elmgren and Henriksson, 2014), and our scoping review shows that using technology enhanced learning by means of smart glasses can be one way to achieve those features.

The results suggests that smart glasses were an asset during simulations. Simulations are known to be beneficial and provide learning opportunities in nursing education. Simulations gives the opportunity to practice several skills, such as critical thinking and clinical judgement. Simulations also increases knowledge, self-confidence, and motivation in nursing education (Hanshaw and Dickerson, 2020). During simulations, nursing students can integrate theory and practice in a safe learning environment (Sundler et al., 2015). Safe learning environments are known to be beneficial for student learning (Elmgren and Henriksson, 2014). After the simulation scenario, reflection of the course of event follows. During the reflection nursing students found that their knowledge deepened. Reflections can enrich nursing students' knowledge and facilitate integration of theory and practice (Sundler et al., 2015). The results in our scoping review indicates that smart glasses provided additional possibilities for learning and reflections. Hence, smart glasses can be used to improve simulations even further.

The results reveal some drawbacks related to the user experience of smart glasses use in nursing education, such as technical issues and the learning curve. Some of the issues might be related to the fact that smart glasses are described as new and novel. This could explain the fact that students faced a learning curve. Users facing a learning curve with smart glasses has been highlighted previously (Romare et al., 2021). The learning curve using a new technical device can be associated with learnability. Research has shown that previous experience of similar products and technology can positively influence adoption of other technical products (Mendoza et al., 2010; Munnukka, 2007). In addition, previous experience also positively influences learnability of new technology for students. Technology that is hard to learn may pose a significant hurdle for actual use. On the contrary, technology that is easy to learn it will enhance adoption and continued use. Further, available support to help resolve problems is important. Hence, how easy it is to learn to use new technology is influenced by user background, the design of the technology, and availability of support (Mendoza et al., 2010). The need for support was noted in our study as well. It is well known that technology is becoming more and more present in healthcare settings today. Therefore, it is imperative to support next generation of nurses by introducing them to technology during nursing education. Technology used today should be introduced, as well as technology that might be used in the future (Risling, 2017). Taken together, using technology enhanced learning in nursing education can be one way to increase learnability for other types of technology in the clinical work as a future nurse.

Further, this scoping review shows that students were distracted by the smart glasses. Smart glasses were a technology used in learning situations, although smart glasses did not necessarily entail technology enhanced learning with focus on "enhanced learning". Distraction from technology is a known problem in clinical nursing practice as well (van Pelt and Weinger, 2017). While distraction most likely is negative for learning, one (maybe unintended) learning outcome can be that students learn how they react to distractions, and how to manage that distraction. This can be valuable knowledge during clinical nursing practice and an asset for patient safety in nursing students' future profession. Since technology enhanced learning aims to enhance the teaching-learning process (Bullock and de Jong, 2013) also unintended learning outcomes must be seen as a useful and valuable effect of technology enhanced learning.

Although 14 references were included in the analysis, only nine addressed the research question regarding how learning was effected from students' perspective. None of them provided qualitative data from individual interviews with students regarding their learning experiences. Since it is argued that the benefits of technology in nursing education is unclear (Goodchild, 2018) it would be interesting to delve deeper into students' experiences of using smart glasses in nursing education in future research. One suggestion is to conduct studies with qualitative design and collect data through individual semi structured interviews or focus groups interviews (Polit and Beck, 2016) with students after smart glass use in nursing education. To describe students' experiences, qualitive content analysis (Polit and Beck, 2016) can used to analyse data. A positive impact on nursing education can also entail positive impact on nursing care as well as on patient outcomes. Accordingly, it would be interesting to investigate if, and if so how, students think that training with smart glasses would effect their knowledge of patient care.

5.2. Methodological considerations and limitations

After conducting this study, the authors agree that a scoping review was a suitable method to answer the aim. It might be argued that the aim was too broad. A broad aim is recommended for a scoping review study to generate a wide coverage. Further, it is suggested that a broad aim reduces the risk of missing relevant references. Although, a broad aim might generate too many articles to include (Arksey and O'Malley, 2005). Our searches using a broad aim generated 25 references to read in full text, and finally 14 of them were included. This number of references were seen manageable and suitable to answer the aim.

Three databases, SCOPUS, PubMed, and ERIC were used during database searches for this study. Searching in additional databases, for example CINAHL, might have generated additional references to include in the analysis. Further, search terms for specific applications such as "augmented reality", "mixed reality", "metaverse", or "video" could have generated more references to include. Although, the focus of this study was smart glasses and their specific characteristics, not specific applications. The specific applications are often used on other platforms such as tablets, smart phones, computers, specific headsets, or cameras. Hence, adding them as search terms would most likely generate a large amount of non-relevant results. Both choice of databases and search terms were discussed with experienced librarians, and other researchers for example within nursing, education, and software engineering. In summary, the number of included references in this scoping study were found sufficient to answer the aim.

Analysis included references from year 2015 to 2021. Technology is constantly evolving, and it is reasonable to assume that this could effect both usability and feasibility of smart glasses in nursing education. Surprisingly, this was not evident in the analysis. On the contrary, both positive and negative aspects of learning experiences as well as used experiences were found in both older and more recent references. Different smart glasses also have different features. Four different brands were used in the included references. Analysis could have been grouped by the different brands. Although, the aim of this study was to give an overview regardless of smart glass brand. Hence, a more open and inductive approach was chosen for analysis.

Another limitation is the fact that nursing education might comprise different content in different countries. In this scoping study, references that clearly stated their connection to nursing education were selected to be read in full text. Although, nursing students learn a variety of skills during their education, and these skills might differ between countries. In some countries nursing students might for example learn to use ultrasound, intubate or to place drains. In Sweden where this scoping study was conducted this kind of tasks is performed by physicians or specially trained nurses, not by nursing students. Hence, references related to this kind of tasks were excluded based on title and/or abstract. The results from different included studies must also be interpreted in their context, since nursing education differs between countries regarding for example student-teacher ratio. In some contexts, smart glasses might therefore be more applicable than in other.

Finally, a limitation of the scoping study methodology is the absence of quality assessment of included studies (Levac et al., 2010). Consequently, it is argued that no actual synthesis of results is made since this assumes that the evidence is weighted. A scoping study can merely provide a description of available research (Arksey and O'Malley, 2005). This is a valid point of view for our scoping study as well. Although, the authors find a description well suited to answer our aim.

6. Conclusions

Smart glasses have potential to be included in learning activities in higher education for future nurses and be part of technology enhanced learning. Using technology in nursing education might be one way to prepare students for future clinical practice since health care is becoming increasingly influenced by technology. Several learning situations with smart glasses have been well evaluated by students, for example using smart glasses to aid reflection and to add information during simulations. In addition, smart glasses could increase student motivation and engagement in learning situations. Nevertheless, drawbacks related to smart glass use were noted in this scoping review. Teachers that want to include smart glasses in higher education for future nurses should learn from previous experiences to avoid unnecessary side effects. For example, there is need for a well-functioning infrastructure and availability of technical support when introducing smart glasses as part of technology enhanced learning.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.nepr.2023.103824.

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