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SYNTHESIS

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Supporting the learning experience of health-related profession students during clinical placements with technology: A systematic review

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Abstract

High quality clinical education is a fundamental component of undergraduate health-related professions programmes. Technological interventions offer potential to support and enhance student learning experiences during clinical placements, i.e. away from the university setting. This review aims to systematically explore, evaluate and summarise the range of technological strategies within the literature regarding support of the student learning experience during clinical placements. A systematic review was conducted using defined search terms, educational and medical subject headings (MeSH). Relevant databases were searched alongside hand searching of citations and grey literature. Experimental studies with technological strategies designed to support student learning during clinical placements were included. A modified version of Kirkpatrick's levels (Barr et al., *Effective interprofessional education: Assumption, argument and evidence*. Blackwell, 2005) was used to evaluate strategies. Twenty-one papers met inclusion criteria. Heterogeneity existed in terms of strategies

and their usage e.g. whether synchronous or asynchronous; targeting individual students or groups A wide range of technological strategies may be employed to support the student learning experience during placements. However, none were identified as being of high quality therefore further research is required to provide stronger evidence to support their use. Consideration should be given to the underlying purpose of the strategy as well as the potential barriers for implementation e.g. acceptability and connectivity. Students should be clearly informed of strategy purpose and requirements, with opportunities to practice prior to placements. Review findings may provide insight to assist educators to develop future support strategies for students on clinical placements during challenging circumstances such as the COVID-19 pandemic.

KEYWORDS
clinical placements, educational technology, healthcare education, student support

Context and implications

Rationale for this study

This systematic review aimed to establish and describe technological methods that are currently being used during clinical placements to support the learning experience of undergraduate students of health-related professions.

Why the new findings matter

The findings indicate that a broad range of technological strategies may be utilised to support the student learning experience during placements, with numerous learner benefits including improved clinical knowledge, increased reflection upon practice, increased peer and staff support, and reduced sense of isolation during placements.

Implications for educators

Educators should clearly explain the strategy purpose and requirements of the student should be clearly explained, with opportunities provided for students prior to placements to practice its use. Balance is required in terms of (a) encouraging student engagement without over burdening the student and (b) moderator involvement to facilitate student engagement without stifling contributions. When selecting a technological support strategy, consideration should be given to (a) potential technological difficulties, such as accessing platforms and (b) acceptability of the strategy for use within a clinical context.

INTRODUCTION

The term 'health professions' refers to a broad range of occupations including medicine and nursing alongside allied health professions such as occupational therapy, physiotherapy, podiatry, radiography, radiotherapy, and speech and language therapy. Clinical placements are an essential component of undergraduate health-related profession programmes. As part of undergraduate degree programmes in allied health professions within the UK, students are required to complete a minimum of 1000 clinical hours outside of Higher Education Institutes (HEI) within a variety of workplace settings. Clinical placements, also known as workplace-based learning or practice placements, may be defined as 'any arrangement in which a … student is present in an environment that provides healthcare or related services to patients or the public. Placements can take place in primary, secondary or community healthcare or social care settings. Students can be actively involved in patient care or they can be observing health or social care processes' (GMC, 2009). Students of health-related professions may also undertake placements in a broad range of settings beyond the healthcare setting, including private, independent and voluntary organisations. Placement experiences are essential to enable students to acquire and develop professional skills and integrate theoretical knowledge into practice. Direct interaction with patients and clients during clinical placements facilitates development of students' clinical judgement, which in turn leads to clinical competence to practise ensuring optimum and effective patient care (COP, 2013).

The student learning experience

The Higher Education Academy (HEA) define the student learning experience as 'a broad range of learning experiences a student encounters within a higher education environment, from pre-arrival contact through to graduation … spanning both formal and informal domains' (HEA, 2019). It is widely agreed that the student learning experience comprises more than purely academic study and subsequent assessment; however, some ambiguity exists regarding the variety of contributing factors. The Student Experience Network of the Society of Research in Higher Education aims to determine what students are learning, in the widest sense of the word, from their experiences within and beyond formal academic study (SRHE, 2019). The network lists a myriad of components including transition, accommodation, learning, internationalisation, diversity and inclusion, development and transformation, engagement, employability, satisfaction, representation and equality. Student Partnerships in Quality Scotland (SPARQS, 2019) list several elements as contributing to student learning experience, including curriculum, learning resources, learning and teaching processes, assessment and feedback, student progression and achievement, guidance and support, and quality enhancement and assurance. It is clear that a broad range of factors, including academic, environmental and social, all impact the student learning experience to varying extents.

Impact of clinical placements

The clinical setting is dynamic, challenging, and occasionally stressful, and time spent in this environment greatly impacts upon the student learning experience (Chesser-Smyth, 2005; McCloughen & Foster, 2018). The additional challenges of the COVID-19 pandemic has resulted in an increasingly pressurised working environment but has also afforded unprecedented learning opportunities (Ulenaers et al., 2021). Students face additional pressures of

being away from the familiarity of the university setting with potentially reduced peer and staff support, and they may also be assessed during placements by clinical staff. Furthermore, students are often placed within different clinical locations and therefore encounter a variety of learning opportunities during their placements, that is, no two students will have an 'identical' placement experience. This may be due to several factors including the variety of clinical facilities and the number of suitable patients and clients available for a student. During placements, students are supervised and educated by clinical tutors (referred to in the literature by several terms, including clinical educators, practice supervisors, placement tutors or fieldwork educators). The variation in the knowledge, skills and experience of clinical tutors will inevitably impact upon clinical placement experiences. Such variety in clinical placement experiences can also lead to challenges in ensuring that students are able to meet curriculum learning objectives. Although cost and availability of clinical placements may be regarded as limiting factors, other variations in placement experiences present students with challenges and opportunities in various forms. Educators are tasked with ensuring that students make the best use of such opportunities arising in the clinical setting to maximise the overall placement learning experience. Interventions that support and enhance the student learning experience during clinical placements, that is, away from the university setting, are therefore of great importance.

Technology enhanced learning

Technology enhanced learning (TEL) may be defined as the application of technology to enhance student learning and it has been increasingly employed by universities into curriculum design (Dunn & Kennedy, 2019). TEL offers the potential benefits of enabling students to engage with educational content at their own time and pace and at a geographical distance (Breen et al., 2016). As a consequence of the COVID-19 pandemic, many HEIs rapidly adopted TEL strategies to deliver educational content online with varying success (Mailizar et al., 2021). During clinical placements, students are scheduled into a busy clinical environment, and the inclusion of technological strategies during the clinical placement period has potential to enhance the student learning experience. A literature scoping exercise found a variety of methods employed to support the student learning experience during placement. Previous reviews have focused on specific aspects of placements, for example, inter-professional learning (Olson & Bialocerkowski, 2014), facilitating reflective practice (McLeod et al., 2015) and the use of summative assessment (Helminen et al., 2016). Both Franklin (2013) and Lekkas et al. (2007) have conducted reviews of placement supervision models. Other research has examined the use of mobile technology during placements (Lea & Callaghan, 2011), while a recent BEME (Best Evidence Medical Education) review focused on use of hand-held devices by students during placements (Maudsley et al., 2019). The present review examines and evaluates available literature regarding the range of technological methods used to support the learning experience during clinical placements for undergraduate health-related profession students.

Research question and review objectives

This review aims to answer the main research question: what technological methods are used during clinical placements to support the learning experience of undergraduate health-related profession students? Review objectives are:

- To establish and describe technological methods that are currently being used during

clinical placements to support the learning experience of undergraduate students of health-related professions (Description).
- To identify the effectiveness of the technology intervention on the student learning experience.
- To evaluate the evidence supporting the use of these methods.
- To determine when such methods are recommended for use (Context).
- To determine the limitations/barriers to implementation and use of these methods, such as Wi-Fi availability, disturbance of clinical activity (Clarification).

METHODS

This review has been completed in accordance with the peer-reviewed protocol published on the BEME website (Jones et al., 2020).

Search strategy

The search strategy including search terms was developed with the support of the information specialist (Health Sciences Subject Assistant Librarian, Ulster University), building on an earlier scoping exercise to identify available literature. The following databases were searched from the date of inception to February 2020: CINAHL, Embase, ERIC, Medline, PsychoINFO, Proquest Education Database, Scopus and Web of Science. An example search strategy is presented in Appendix S1. The reference sections of selected studies were searched in order to identify further studies that met the eligibility criteria. Forward citation searching was also used to identify literature, including the use of Google Scholar to review 'cited by' information.

Study selection criteria

The PICO format (Riva et al., 2012) was used to develop inclusion and exclusion criteria.

- *Population*: included students enrolled in undergraduate degree programmes in health-related professions. This includes the following professions: medicine, nursing and midwifery, dentistry, dietetics, occupational therapy, paramedic science, podiatry, pharmacology, physiotherapy, radiography and radiotherapy, and speech and language therapy. Postgraduate students were not included—in contrast to undergraduate students (who are acquiring basic key skills essential for their profession) postgraduate (PG) students are acquiring additional, advanced skills. These PG students have also been found to adopt a different learning style and have different support needs in comparison to undergraduate students (Humphrey & McCarthy, 1999; Samarakoon et al., 2013).
- *Intervention*: the PICO format typically defines an intervention as a treatment provided to study participants (Santos et al., 2007). For the purposes of this review, 'intervention' referred to a technology-based strategy that is employed by university educators for the specific purpose of facilitating students' learning experience during placement. For inclusion in this review, the strategy must be deployed during the clinical placement time-period itself, rather than before or after placement, or on university campus.
- *Comparator*s: comparators of interventions were considered.
- *Outcome measures*: studies reporting outcomes relating specifically to the student were considered, such as development of clinical knowledge, peer support and academic support.

Study titles and abstracts were screened independently against the inclusion and exclusion criteria by two members of the review team (lead reviewer plus one other). The full texts of studies which met the eligibility criteria were obtained and screened by two members of the review team (lead reviewer plus one other). An important aspect of conducting a systematic review is the selection of relevant articles and the reliability of decisions made by reviewers during this process (Belur et al., 2021). Kappa calculations are most commonly used as indices of interrater reliability, with a score of 1 indicating perfect agreement, >0.75 indicating excellent, between 0.40 and 0.75 indicating fair to good and <0.40 indicating poor agreement (Gisev et al., 2013). Cohen's kappa was calculated as 0.67 at the article screening stage, which indicates fair to good agreement. Although the articles were screened independently by two reviewers, where disagreement occurred, a third member of the review team was available for consultation to agree a consensus viewpoint.

Data extraction

A data extraction form based on BEME guidance (Hammick et al., 2010) was piloted and refined as part of an initial scoping exercise. The data extraction form was developed following the initial pilot phase by inclusion of Maxwell's six dimensions of quality (Maxwell, 1992). The finalised form was further discussed amongst the team to ensure clarity of understanding of each section prior to final data extraction. This was used by the review team to assess study content and extract data relating to study populations, interventions and outcomes. Data were extracted independently by two members of the review team. A sample appraisal form is available in Appendix S2.

Quality assessment of included studies

To ensure consistency, all studies were separately appraised by the lead reviewer and one other member of the review team. Where disagreement occurred, a third member of the review team appraised the article and to reach consensus viewpoint. Reported outcomes were recorded using Maxwell's six dimensions of quality (Maxwell, 1992), which have been used by previous systematic reviews (Maudsley et al., 2019) to assess quality of interventions relating to:

(i) effectiveness of the technology strategy for supporting the student learning experience during clinical placements (how it is perceived to work)
(ii) acceptability (student preference and satisfaction)
(iii) efficiency (relating outputs to inputs)
(iv) access (including barriers to implementation and uses, benefits and drawbacks)
(v) equity ('fairness' of the strategy relating to the student and professionalism)
(vi) relevance (appropriateness of the strategy for supporting the student learning experience during clinical placements).

As per previous BEME reviews, effectiveness of intervention claims were classified using a modified version of Kirkpatrick Hierarchy to evaluate study outcomes (Table 1) (Pallari et al., 2019; Uygur et al., 2019). Eligible studies were appraised using the BEME 'Strength of Findings' model (Hammick et al., 2010). Using this model, reviewers evaluated the appropriateness of the study design, analysis and implementation for answering the research question. As per previous BEME systematic reviews, decisions regarding assessment of research quality were based upon key quality indicators as cited by Pallari et al. (2019)

TABLE 1 Kirkpatrick hierarchy (Barr et al., 2005)

Level 1	Reaction	Participants' views on the learning experience, its organisation, presentation, content, teaching methods, and quality of instruction
Level 2A	Learning—Change in attitudes	Changes in the attitudes or perceptions amongst participant groups towards teaching and learning
Level 2B	Learning—Modification of knowledge or skills	For *knowledge*, this relates to the acquisition of concepts, procedures and principles; for *skills*, this relates to the acquisition of thinking/problem-solving, psychomotor and social skills
Level 3	Behaviour—Change in behaviours	Documents the transfer of learning to the workplace or willingness of learners to apply new knowledge and skills
Level 4A	Results—Change in the system/ organisational practice	Refers to wider changes in the organisation, attributable to the educational programme
Level 4B	Results—Change amongst the participants' students, residents or colleagues	Refers to improvement in student or resident learning/performance as a direct result of the educational intervention

adopted from Hothersall (2016). The review team refined this to exclude psychometrics as it is anticipated that not all identified studies will include psychometric testing, which would have impacted upon the overall study score.

Synthesis of evidence

Based on results of the initial scoping exercise, the review team anticipated that findings would be both qualitative and quantitative. Due to the anticipated heterogeneity of the data, the potential for any statistical analysis is unlikely. Consequently, the review team decided to adopt a narrative synthesis approach. This approach is recommended where alternative synthesis methods are inappropriate due to variation in research designs producing qualitative and/or quantitative findings (Popay et al., 2006).

RESULTS

The literature search yielded an initial 1896 citations with a further 18 identified from reference lists and hand searching. Following removal of duplicate publications in RefWorks, 1689 citations were available for screening. Study titles and abstracts were screened independently by two members of the review team, and 67 full text articles which met the eligibility criteria were obtained. These were screened independently by two members of the review team, with any disagreements being resolved by discussion. Twenty-one articles were deemed to meet the inclusion criteria and were included in the present review. Salient details of the studies included in the review may be found in Appendix S3. This process is outlined in the preferred reporting items for systemic reviews and meta-analysis (PRISMA) diagram (Figure 1).

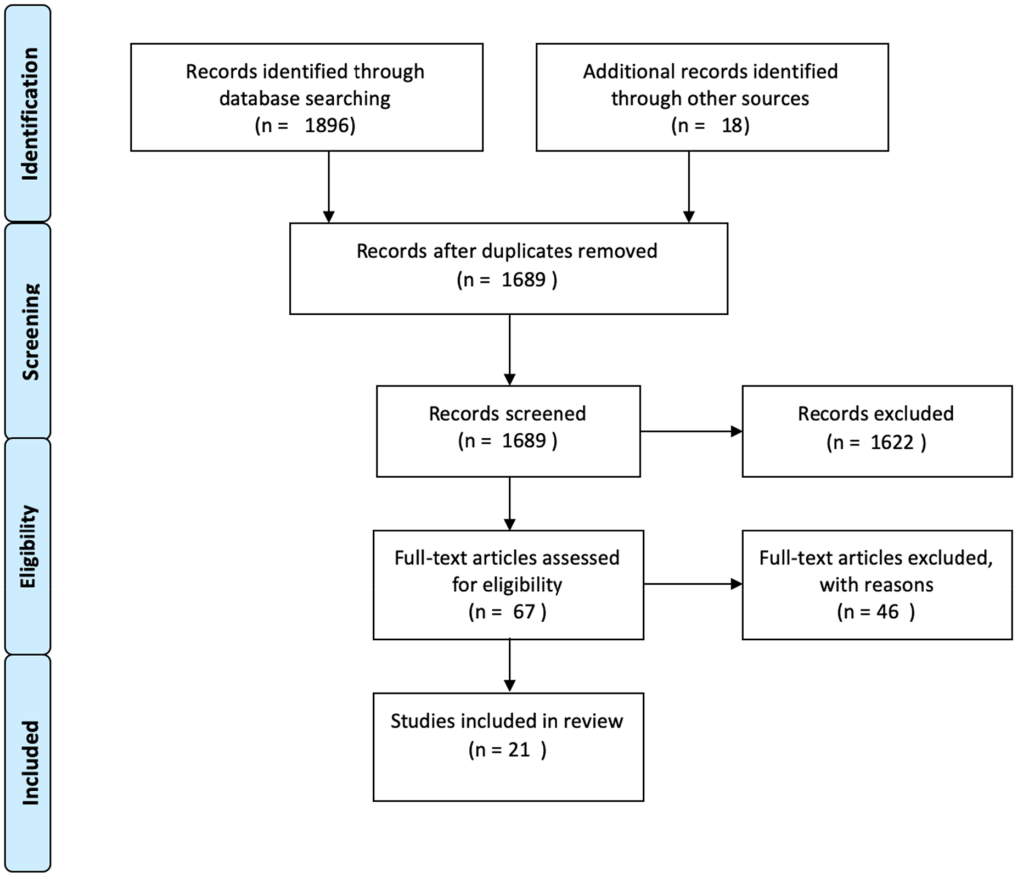

FIGURE 1 PRISMA diagram of search process.

Reason for study exclusion

During the initial stage of record screening, the main reasons for study exclusion were that: (i) participants did not meet review inclusion criteria (449/1622); (ii) no technological strategy was used or use of technology was incidental and not the main focus of the study (440/1622); (iii) the study related to clinical practice but not supporting the student learning experience during placements (413/1622); (iv) the study was not relevant to the research question (249/1622); (v) the technological strategy did not meet review inclusion criteria, such as simulation (51/1622); and (vi) the technological strategy did not occur during placements (20/1622). During full text screening, main reasons for study exclusion were: (i) use of technology was incidental and as such not subject to evaluation (17/46); (ii) the technological strategy was deployed before or after placements, or on the university campus rather than during the clinical placement period itself (15/46). Further reasons for study exclusion were that the article was descriptive/opinion rather than evaluative (8/46), or the study was nor relevant (e.g., use of simulation) (4/46); or that students were not the focus of the research (2/46).

Study quality and characteristics

The 21 articles selected for inclusion were published between 2003 and 2019. The majority of studies were of mixed methods design, combining both qualitative and quantitative research methods (19/21), whereas two studies used qualitative methodology (Reynolds & Fell, 2011; Tan et al., 2010). All studies except two included clearly defined aims and objectives (Andrews et al., 2010; McLeod et al., 2012). Assessment of the research quality found that 10 of the 21 studies scored 3/5, with the remainder scoring less than 3. Similarly, appraisal scores using the BEME 'Strength of Findings' model (Hammick et al., 2010) were mostly recorded as either 3/5 (8/21) or 2/5 (12/21) indicating that conclusions can probably be based upon results or that results are ambiguous but there appears to be a trend, respectively. Reasons behind such scores were based upon factors such as lack of repeatability. For example, lack of detail regarding placement duration (Lin & Shen, 2013; Morris & Maynard, 2010), year group (MacKay & Harding, 2009), details of strategy usage (Pimmer et al., 2018), and sample size (Andrews et al., 2010). Only two studies included comparators as part of study methodology (Ladyshewsky & Gardner, 2008; Morley, 2014).

A wide range of medical and health professionals were noted, with the largest proportion being nursing (9/21). Other professions included occupational therapy (OT) (4/21), physiotherapy (3/21) and speech and language therapy (SLT) (1/21). Four studies were multidisciplinary and included: (i) SLT and medicine (Andrews et al., 2010); (ii) podiatry, social work, clinical psychology, nursing (learning disability) (Lea & Callaghan, 2011); (iii) OT and SLT (McLeod & Barbara, 2005); and (iv) nursing, OT and radiography (Young et al., 2010). The location of studies varied, with the majority being reported from Australia (8/21). Other locations included the United Kingdom (7/21) and Ireland (2/21), with other studies from New Zealand, Nigeria, Taiwan and USA (each 1/21). A summary of study characteristics is shown in Table 2.

Range of technological strategies

A variety of technological strategies to support the learning experience of undergraduate health-related profession students during clinical placements were reported. This included blogging (4/21); video conferencing (3/21); chatroom (2/21); use of mobile devices (3/21); web-based resources (2/21); and messaging platforms (SMS and WhatsApp) (3/21). Two studies used multiple strategies: (i) vodcasts and videoconferencing (Andrews et al., 2010); and (ii) Facebook, wiki and email group (Morley, 2014). The majority of studies used asynchronous technological strategies (15/21), whereby the student participates in the strategy by themselves at a time of their choosing. Remaining studies were either synchronous (5/21) or a combination of both (1/21). Although some strategies were designed for use by individual students (9/21), the majority of studies explored strategies requiring collaboration amongst a group of students (15/21). Most studies reported technological strategies that involved the contributions of a university facilitator or moderator (14/21). These studies utilised strategies such as blogging (4/14), online chatrooms (2/14), videoconferencing (4/14), SMS texting (2/14), and an online discussion board (1/14). One study investigated a variety of strategies, all of which required university facilitator involvement—Facebook, wiki and email group (Morley, 2014). Those studies that did not require a university facilitator or moderator involved individual students accessing asynchronous support or materials either on computer or their own mobile device. Exceptions to this were a study by Pimmer et al. (2018), that investigated the use of instant messaging amongst the student group, and Lin and Shen (2013) who explored the use of blogging during placements. Over half of the studies involved specific activities being set for students to complete (12/21). These included

TABLE 2 Characteristics of studies

Authors	Profession(s)	Participants	Country
Andrews et al. (2010)	MDT—speech pathology and medical students	Unclear	Australia
Daniels (2010)	OT	121	UK
DeLeo and Geraghty (2018)	Nursing (midwifery)	29	Australia
Denny and Higgins (2003)	Nursing (psychiatry)	2	Ireland
Furness and Kaltner (2015)	OT	31	Australia
Hardy et al. (2016)	Nursing (mental health)	12	Australia
Hart et al. (2019)	Nursing (mental health)	8	UK
Ladyshewsky and Gardner (2008)	Physiotherapy	38	Australia
Lea and Callaghan (2011)	MDT—podiatry, social work, clinical psychology, nursing (learning disability)	80	UK
Lin and Shen (2013)	Nursing	48	Taiwan
MacKay and Harding (2009)	Nursing	41	New Zealand
McLeod and Barbara (2005)	MDT—OT & SLT	97	Australia
McLeod et al. (2012)	SLT	64	Australia
Morley (2014)	Nursing	52	UK
Morris and Maynard (2010)	Physiotherapy and nursing	30	UK
Pimmer et al. (2018)	Nursing	196	Nigeria
Reynolds and Fell (2011)	Nursing	20	UK
Tan et al. (2010)	Physiotherapy	83	Australia
Wiid et al. (2013)	OT	76	Ireland
Wooster (2004)	OT	23	USA
Young et al. (2010)	MDT—nursing (adult and children); OT, radiography	59	UK

tasks such as creating a blog post (Ladyshewsky & Gardner, 2008; Lin & Shen, 2013; Tan et al., 2010; Wiid et al., 2013); submitting case studies for discussion (Wooster, 2004); problem-based learning activities (Denny & Higgins, 2003; Lea & Callaghan, 2011; Morris & Maynard, 2010; Reynolds & Fell, 2011); and participation in videoconferencing tutorials (Andrews et al., 2010; Furness & Kaltner, 2015; Hardy et al., 2016). A few studies clearly used strategies/platforms that provided notifications to remind students to contribute (4/21). These studies all involved either SMS or MMS texting. However, it is unclear whether the platforms used by the majority of studies involved students being given any form of notification or reminder. A summary of strategy characteristics is shown in Table 3.

Quality of study outcomes

The majority of studies were found to include four of the previously listed Maxwell dimensions of quality of interventions (Maxwell, 1992). These were: (i) effectiveness (how the strategy is perceived to work); (ii) acceptability (student preference and satisfaction); (iv) access (including barriers to implementation and uses, benefits and drawbacks) and (vi) relevance (appropriateness of the strategy). Sixty-six per cent of the studies (14/21) were found not to have reported outcomes aligned with dimension (iii) efficiency of the strategy (relating

TABLE 3 Characteristics of technological strategy employed by studies

Authors	Technological strategy	Synchronous	Asynchronous	Individual student	Multiple students	University facilitator/moderator involved
Andrews et al. (2010)	(1) Own mobile devices—vodcasts and (2) videoconferencing	×	×	×	×	×
Daniels (2010)	Online discussion board		×		×	×
DeLeo and Geraghty (2018)	Smartphone to access EBP resources		×	×		
Denny and Higgins (2003)	Computer-assisted learning (CAL) via interactive multimedia (IMM) CD-ROM package		×	×		
Furness and Kaltner (2015)	Videoconferencing	×			×	×
Hardy et al. (2016)	Videoconferencing—Skype	×			×	×
Hart et al. (2019)	Videoconferencing—BBL collaborate	×		×		×
Ladyshewsky and Gardner (2008)	Blogging (www.blogger.com)		×		×	×
Lea and Callaghan (2011)	Mobile devices issued to students (Camcorder, mobile, iPod)		×	×		
Lin and Shen (2013)	Blogging (http:/www.wretch.cc/blog)		×		×	
MacKay and Harding (2009)	SMS		×	×		×
McLeod and Barbara (2005)	Chatroom	×			×	×
McLeod et al. (2012)	Chatroom	×			×	×
Morley (2014)	Facebook, wiki, email group		×		×	×
Morris and Maynard (2010)	Mobile device (HP iPAQ) and web-based resources		×	×		
Pimmer et al. (2018)	WhatsApp use during placement		×		×	
Reynolds and Fell (2011)	e-Learning resources (via MOODLE)		×	×		
Tan et al. (2010)	Blogging (www.blogger.com)		×		×	×
Wiid et al. (2013)	Blogging (www.blogger.com)		×		×	×
Wooster (2004)	Web-based resources		×		×	×
Young et al. (2010)	SMS		×	×		×

outputs to inputs). Approximately 62% of studies (13/21) were noted to have included dimension (v) equity (fairness of the strategy relating to the student and professionalism).

The majority of studies reported Kirkpatrick levels at level 1 (learner reaction), 2A (learning—change in attitude) and 2B (learning—modification of knowledge or skills), with approximately half (11/21) reporting Kirkpatrick level 3 (change of behaviour) and few reporting higher levels of 4A (change in the system/organisational practice) (4/21) and 4B (change among students) (1/21). Where higher levels were reported, this was indicated by continued use of the strategy following the period of research (MacKay & Harding, 2009; McLeod et al., 2012; McLeod & Barbara, 2005; Wiid et al., 2013) or by an improvement in academic performance during clinical placements where there had previously been student difficulties prior to strategy implementation (Wooster, 2004). Kirkpatrick levels were analysed to ascertain if outcomes were positive, neutral, negative, mixed or not reported. Analysis indicated that more positive outcomes were reported than mixed outcomes. No studies reported solely negative or neutral learner outcomes; these were always reported alongside positive outcomes and thus were categorised as 'mixed' for the purposes of this analysis (Table 4).

Reported benefits for learners

Reported benefits for learners included: improved communication with staff and/or with other students; development of clinical knowledge; reduced sense of isolation during placements; academic support from staff; pastoral support from staff; peer support; reflection upon clinical practice and development of IT skills. Almost all studies reported learner outcomes of improvement to clinical knowledge (16/21). This was represented by a range of reported outcomes, such as development of clinical reasoning (Tan et al., 2010) or by improvement in academic performance where there had previously been difficulties prior to strategy implementation (Wooster, 2004). Eight studies reported that the technological strategies resulted in increased reflection upon clinical practice by students (e.g. blogging—Lin & Shen, 2013; online discussion board—Daniels, 2010; videoconferencing—Hardy et al., 2016; WhatsApp messaging—Pimmer et al., 2018). Peer support was identified as a learner outcome by 13/21 studies that employed technological strategies involving multiple students (e.g. videoconferencing, online discussion boards, blogging, WhatsApp). These studies also reported that the strategy resulted in improved communication with other students, however only 7/21 reported reduced sense of isolation during placements as a learner outcome.

TABLE 4 Analysis of Kirkpatrick levels of reported learner outcomes

Kirkpatrick level	Positive	Mixed (positive and negative)	Not reported
Level 1—Reaction	6	14	1
Level 2A—Learning—Change in attitudes	14	1	6
Level 2B—Learning—Modification of knowledge or skills	11	5	5
Level 3—Behaviour—Change in behaviours	2	9	10
Level 3A—Change in the system/organisational practice	4	0	17
Level 4A—Change in the system/organisational practice	4	0	17
Level 4B—Change amongst the participants: Students, residents or colleagues	1	0	20

Over half of the studies (57%, i.e. 12/21) reported improved communication with staff as a learner outcome. These studies employed strategies including videoconferencing (Furness & Kaltner, 2015; Hardy et al., 2016), online discussion boards (Daniels, 2010), chatrooms (McLeod et al., 2015; McLeod & Barbara, 2005) and SMS messaging (MacKay & Harding, 2009; Young et al., 2010), and involved academic staff in the role of facilitator or moderator. Interestingly, where blogging was used as a technological strategy involving a member of university staff as a moderator, students did not report improved communication with staff as an outcome. Although all studies in this category also reported academic support from staff as a learner outcome, only 5/21 reported pastoral support from staff (chatroom—McLeod et al., 2015; Morley, 2014; SMS messaging—MacKay & Harding, 2009; Young et al., 2010; videoconferencing—Hart et al., 2019). Few studies reported improved IT skills as learner outcomes (4/21) (computer-assisted learning—Denny & Higgins, 2003; videoconferencing via Blackboard Collaborate—Hart et al., 2019; chatroom—McLeod et al., 2015; web-based resources—Wooster, 2004). A summary of reported learner outcomes is shown in Table 5.

Barriers to implementation of strategies

A range of barriers to implementation of technological strategies were reported by the studies. Despite the heterogeneity of strategies, the most frequently noted barrier was, unsurprisingly, technological issues (9/21). This was due to a range of factors including (i) internet access (McLeod et al., 2015; McLeod & Barbara, 2005); (ii) challenges using devices (Andrews et al., 2010; Morris & Maynard, 2010); and (iii) glitches in the software programme (Hart et al., 2019). A second barrier was students' IT abilities, noted by one third of the studies (7/21). This included the lack of ability of students to use online systems such as blogs (Ladyshewsky & Gardner, 2008; Wiid et al., 2013); chatrooms (McLeod & Barbara, 2005); and videoconferencing systems (Hart et al., 2019). Several studies (7/21) reported issues regarding additional workload posed by involvement in particular strategies and time limitations of students completing activities during the busy placement period (e.g. online discussion board—Daniels, 2010; blogging—Lin & Shen, 2013; web-based resources—Reynolds & Fell, 2011). Other barriers to implementation that were reported included a lack of clarity of purpose of the technological strategy or relevance to students (Daniels, 2010; Denny & Higgins, 2003; Wiid et al., 2013); and concerns relating to privacy and security of the particular system (videoconferencing via Skype—Hardy et al., 2016; blogging—Wiid et al., 2013). Interestingly, 2/21 studies reported lack of moderator involvement as a barrier (online discussion board—Daniels, 2010; computer-assisted learning—Denny & Higgins, 2003), and 2/21 reported too much moderator involvement as a barrier (blogging—Ladyshewsky & Gardner, 2008; Wiid et al., 2013). Four studies noted that students reported lack of engagement by other students (or a tendency to 'lurk' within the area without contributing) as a dissuading factor to use (online discussion board—Daniels, 2010; blogging—Ladyshewsky & Gardner, 2008; Lin & Shen, 2013; web-based resources—Wooster, 2004). Some other factors were noted as barriers including: (i) students feeling lost in a large group online (videoconferencing—Andrews et al., 2010; Furness & Kaltner, 2015); (ii) sense of inappropriateness of using technology within a clinical setting (smartphone use—DeLeo & Geraghty, 2018); and (iii) the need to future-proof support strategies (mobile devices—Lea & Callaghan, 2011). Some studies also reported that although strategies were perceived as useful, they were not a substitute for face-to-face contact with university staff where more complicated issues arose (videoconferencing—Hart et al., 2019; SMS messaging—Young et al., 2010).

TABLE 5 Reported learner outcomes identified by studies

Authors	Learner outcomes identified by study								
	Communication with staff	Communication with other students	Clinical knowledge development	Anti-isolation	Academic support (from staff)	Peer support	Pastoral support (from staff)	IT skills	Reflection on practice
Andrews et al. (2010)	Y	Y	Y		Y				
Daniels (2010)	Y	Y	Y		Y	Y			Y
DeLeo and Geraghty (2018)			Y						
Denny and Higgins (2003)			Y		Y			Y	
Furness and Kaltner (2015)	Y	Y	Y	Y	Y	Y			
Hardy et al. (2016)	Y	Y	Y		Y	Y			Y
Hart et al. (2019)	Y				Y		Y	Y	
Ladyshewsky and Gardner (2008)		Y	Y	Y	Y	Y			Y
Lea and Callaghan (2011)	Y	Y	Y		Y	Y			Y
Lin and Shen (2013)		Y	Y			Y			Y
MacKay and Harding (2009)	Y				Y		Y		
McLeod and Barbara (2005)	Y	Y	Y	Y	Y	Y			
McLeod et al. (2012)	Y	Y	Y	Y	Y	Y	Y	Y	
Morley (2014)	Y	Y			Y	Y	Y		
Morris and Maynard (2010)			Y						
Pimmer et al. (2018)		Y		Y		Y			Y
Reynolds and Fell (2011)			Y						
Tan et al. (2010)		Y	Y			Y			Y
Wiid et al. (2013)		Y	Y			Y			Y
Wooster (2004)	Y	Y	Y	Y	Y	Y		Y	
Young et al. (2010)	Y			Y	Y		Y		

DISCUSSION

The present review focused on establishing and describing technological methods used during clinical placement to support the learning experience of undergraduate students of health-related professions. In total, 21 studies were identified for inclusion in the review, and involved a variety of interventions including blogging, chatrooms, wikis, messaging platforms and videoconferencing systems. Publication dates of the included articles ranged between 2003 and 2019. Ongoing advances in technology may in part account for the heterogeneity of technological strategies. While the higher education sector pivoted rapidly to digital solutions during the COVID-19 pandemic (Watermeyer et al., 2021), technological strategies such as those within the present review may be regarded as resilient to such circumstances as they enable provision of student support without the need for face-to-face interaction. The following discussion provides insight into these strategies and their deployment, and may assist educators to develop 'future-proof' support strategies for students on clinical placements, which will offer resilience should similar challenging circumstances arise.

Employment of strategies

McLeod and Barbara (2005) and McLeod et al. (2012) evaluated the use of chatrooms, in both instances requiring students to log on once per week, with an academic mentor facilitating the chat. This enabled synchronous interaction and peer support amongst the student cohort during clinical placements. However, internet accessibility and not enough students in attendance for the synchronous sessions were seen as the main disadvantages. In contrast, blogging offers an asynchronous means of providing peer interaction and support during placement. Of the studies which evaluated the use of blogging (4/21), this strategy was used to support the student learning experience by promoting reflective practice, with Tan et al. (2010) exploring how this was linked to clinical reasoning and metacognition. Participants were required to post an original entry per week based upon reflections on the clinical placement experiences and comment on those of other students. All studies had minimum activity requirements per week, and an academic moderator was involved to encourage discussion regarding relevant topics. All studies reported that blogging fostered interaction and collaboration amongst participants during placements, resulting in support and learning from peers on other placement sites. Tan et al. (2010) assessed blog use (completion of weekly requirements: pass/fail) and proposed group rewards could be used to further promote engagement. Both Wiid et al. (2013) and Ladyshewsky and Gardner (2008) reported that academic moderators should be mindful in their role as facilitator in order not to stifle activity by commenting before participants have had opportunity to do so.

Furness and Kaltner (2015) and Hardy et al. (2016) both used videoconferencing to host a series of online sessions where participants could reflect together upon their clinical placement learning experience, facilitated by an academic moderator. Videoconferencing was used as a means of facilitating communication between peers, with the moderator playing an important role in encouraging interaction. In contrast, Hart et al. (2019) used videoconferencing to host discussions between the participant, clinical educator and lecturer in order to provide tailored, individual support. Unlike blogging, videoconferencing provided synchronous engagement which may prove more beneficial where students require immediate feedback and discussion. Three studies used messaging platforms (SMS and WhatsApp) to support the student learning experience with each adopting a different approach, although no minimum texting requirements were set. Pimmer et al. (2018) evaluated student-led interactions on WhatsApp during placement and reported increased peer support and reduced sense of isolation. Young et al. (2010) investigated student-led SMS interactions with

staff, whilst MacKay and Harding (2009) evaluated staff-initiated SMS to provide support. All studies remarked on the low cost, efficiency and immediacy of messaging platforms, but the limited nature of text messages inevitably constrains the level of support and feedback which may be offered to students. The use of mobile devices to support the student learning experience was evaluated by three studies. Both DeLeo and Geraghty (2018) and Morris and Maynard (2010) explored participants' use of smart phones/Personal Digital Assistants (PDAs) to access online resources for clinical decision-making purposes, and noted self-reported improvements in knowledge and skills. Lea and Callaghan (2011) explored a range of mobile devices including camcorders, iPods and mobile phones for enhancing learning during clinical placements amongst a range of AHP students. However, the authors noted that greater training was required to make explicit the purpose and use of the mobile device for learning support, as this was reported as unclear by the majority of students. It is worth considering variety in students' technical abilities when utilising mobile devices, or indeed other technological strategies.

Synchronous versus asynchronous deployment

The majority of studies used asynchronous technological strategies (15/21), with remaining studies using synchronous strategies (5/21) or a combination of both (1/21). Asynchronous strategies facilitate communication between users at their own pace, and examples noted by the review include communication tools such as blogs (Ladyshewsky & Gardner, 2008; Lin & Shen, 2013; Tan et al., 2010; Wiid et al., 2013) and discussion boards (Daniels, 2010). Findings indicated several benefits arising from such asynchronous strategies, including:

- Accessing information for self-directed learning (DeLeo & Geraghty, 2018; Denny & Higgins, 2003).
- Being encouraged to reflect on one's own practice (Ladyshewsky & Gardner, 2008).
- Communication and sharing of information with peers (Daniels, 2010; DeLeo & Geraghty, 2018).
- Opportunity to process one's own thoughts (Ladyshewsky & Gardner, 2008).
- Reinforcement of learning and support from peer group (Daniels, 2010).

Studies which utilised synchronous strategies such as videoconferencing and chatrooms indicated benefits including:

- Opportunities to debrief (Furness & Kaltner, 2015).
- Reflection on practice (Furness & Kaltner, 2015; Hardy et al., 2016).
- Communication with peers and tutors (Andrews et al., 2010; Furness & Kaltner, 2015; McLeod et al., 2012).
- Motivation for learning (Furness & Kaltner, 2015; Hardy et al., 2016).

Whilst asynchronous strategies offer numerous advantages, including ability of the participants to engage and progress at a pace that is suitable to them, previous reviews have found synchronous strategies to be effective in learner engagement (Ashokka et al., 2020). There is some evidence indicating that, in terms of web-based learning, synchronous communication facilitates learning more than asynchronous communication (Sitzmann et al., 2006). It has been proposed that this may be due to asynchronous methods resulting in weaker engagement by students with subsequent feelings of disconnection from their cohort (Serrano et al., 2019). However, as students are in a variety of settings and have

differing commitments during clinical placement, it may not always be possible to employ synchronous strategies.

The phenomenon of 'lurkers' was noted by some studies that used asynchronous strategies such as discussion boards (Daniels, 2010; Ladyshewsky & Gardner, 2008; Wooster, 2004). Lurkers may be described as participants who join an online community and will read/watch comments of others without participating themselves (Speily et al., 2020). A review by Sun et al. (2014) noted that there are a variety of reasons for lurking behaviour, such as lack of confidence to contribute (as noted by Daniels, 2010), and concerns relating to safety or security of the online platform (Wiid et al., 2013). However, participants are often able to satisfy their need for knowledge via this activity and lurking can be regarded as a first step of engagement (Salmon, 2003).

Individual versus group approach

The majority of studies explored strategies requiring collaboration among a group of students (15/21). Those strategies which targeted individual students utilised methods involving increasing accessibility of e-learning resources (DeLeo & Geraghty, 2018; Denny & Higgins, 2003; Morris & Maynard, 2010; Reynolds & Fell, 2011). These methods were largely asynchronous, affording the student the opportunity to access support at a time and place of their own choosing as and when the need arose. Such methods can prove very successful for self-motivated learners but do not offer the advantages of an increased sense of engagement, as seen with synchronous strategies (Hrastinski, 2008).

As would be expected, findings indicate strategies targeting groups of students result in outcomes such as improved communication and support. This included pastoral as well as academic support from university facilitators during clinical placement (Daniels, 2010; Wooster, 2004). Technological strategies aimed at supporting groups of students also facilitated peer support such as communication and encouragement from classmates (Wooster, 2004). Further to this, group strategies were found to facilitate peer learning. For example, both the use of asynchronous online discussion boards (Tan et al., 2010) as well as synchronous chatrooms (McLeod et al., 2012) enabled learning from clinical situations that arose during placements to be shared among and reflected upon among the student cohort. Peer collaboration is purported to enhance development of reflection and critical thinking skills among students (Daniels, 2010). It was postulated that the social constructionist discourse, which occurs as a result of engagement with the strategy, facilitates this process (Ladyshewsky & Gardner, 2008).

Technological strategies as a solution against isolation and stress during placement

Although studies reported improvements in communication with other students, only 7/21 reported a reduced sense of isolation during placement as a learner outcome. This may be because isolation was not specifically explored by the investigators or included in the study. Where studies adopted group-based strategies, a sense of collegiality and community were noted outcomes (Hardy et al., 2016). As time progresses and participants continue to engage with the strategy, a sense of trust amongst participants is noted to develop (Ladyshewsky & Gardner, 2008). Levett-Jones and Lathlean (2008) stated that, although a personal and contextual concept, the sense of 'belongingness' can be considered a result of how accepted, connected and included that an individual feels within a group and impacts upon the extent to which a student may engage in clinical learning opportunities. Further

to this, strategies that offered potential for contact with the university facilitator provided a sense of reassurance to students during placement (Young et al., 2010). This study explored SMS messaging between a university facilitator and students, and noted that texting offered the additional benefit of privacy and a quicker means by which students may seek support. The improved communication provided by strategies during placement (when students are away from normal support systems of staff and peers on campus) has potential to negate the development of feelings of isolation and stress where these may arise.

As previously stated, the majority of studies were of mixed methods design, combining both qualitative and quantitative research methods (19/21), while the remaining two studies used qualitative methodology (Reynolds & Fell, 2011; Tan et al., 2010). Strength of findings were mostly recorded as either 3/5 (8/21) or 2/5 (12/21) indicating that conclusions can probably be based upon results or that the results are ambiguous but there appears to be a trend, respectively. Similarly, the review noted research quality scores of 3/5 (10/21 studies), with the remainder falling below this. The reasoning behind such scores was lack of detail regarding placement duration (Lin & Shen, 2013; Morris & Maynard, 2010), year group (MacKay & Harding, 2009), details relating to strategy usage (Pimmer et al., 2018), and small sample size (Andrews et al., 2010; Daniels, 2010; DeLeo & Geraghty, 2018; Denny & Higgins, 2003; Furness & Kaltner, 2015). Greater detail regarding strategy deployment and evaluation methods alongside larger sample sizes should be considered to enhance any future studies in this area.

Barriers to deployment of technological strategies

The review identified several barriers to deployment of technological strategies. Connectivity was noted as an issue by several studies (Andrews et al., 2010; DeLeo & Geraghty, 2018; Hardy et al., 2016). Computer malfunctions and other technological issues were reported (Wooster, 2004). Although technological advances should result in a reduction of connectivity issues over time, it is important to note this as a potential issue, particularly for students in rural locations (McLeod et al., 2012; McLeod & Barbara, 2005).

In addition to the above, time constraints were also noted as a potential barrier to student engagement with the strategy. During clinical placement, students are often thrust into busy and often stressful working environments. Whereas the implementation of technological strategies may be viewed by the educator as beneficial, students can perceive them to be an additional burden during their clinical placements, which are often busy (Daniels, 2010); although they would still be willing to participate due to perceived benefits of the strategy (Wiid et al., 2013; Wooster, 2004). In such circumstances, students may be encouraged to engage by incorporating the strategy as part of their assessment during clinical placements (Tan et al., 2010). However, it was reported that (where directed activities were set) incentivising students resulted in some of the group only completing the minimum required activity, causing the researchers to query if greater engagement, and thereby peer assisted learning, would have been achieved if minimum targets had not been set (Tan et al., 2010). There is arguably a balance to be struck between encouraging engagement with the strategy and not overburdening students who are working in busy clinical environments (Wiid et al., 2013).

Moderator involvement

The need for balance was also reported with regards to the involvement of the university facilitator, and it is well established that moderator involvement has the potential to positively impact upon student activity by promoting and facilitating student interactions (Suler, 2004).

Although the presence of a university moderator was found to encourage and facilitate engagement, too much moderator activity was reported as having a potentially negative impact—for example, the stifling of discussion board responses by students (Daniels, 2010). Furthermore, students were mindful of the contents of their blog posts in light of the presence of a university facilitator (Ladyshewsky & Gardner, 2008). This is not necessarily disadvantageous, as the presence of a university facilitator can encourage participants to be mindful of the true purpose of using the strategy, and add context to reflections upon clinical learning.

Uncertainty around usage

Concerns relating to the safety and the security of technological strategy were reported. For example, users of mobile phones and smartphones in the clinical setting perceived that clinicians held negative opinions of their usage (DeLeo & Geraghty, 2018; Young et al., 2010). However, there is evidence to suggest that use of mobile technologies is becoming more acceptable in clinical settings (Basu et al., 2020; Illiger et al., 2014). It is therefore important to consider if students are able to make use of the technological strategy during placements—for example, accessing smartphones or particular websites may not be permitted in the clinical setting (DeLeo & Geraghty, 2018). Concerns were also expressed regarding the security of online platforms such as Facebook and blogging sites in terms of potential breaches of confidentiality if the information shared were to reach the public domain (Wiid et al., 2013). Educators should consider the importance of clear protocols relating to the confidentiality of postings and acceptable usage guidelines when implementing a technological strategy involving such platforms.

Several studies noted the importance of enabling students to experiment and practise using the technology prior to attendance on placements, postulating that this will engender confidence among students and therefore encourage more engagement in the strategy during placement (Daniels, 2010; Denny & Higgins, 2003; Ladyshewsky & Gardner, 2008). Guidelines for usage were also suggested as enhancing student confidence and competence in engaging with the technological strategy (DeLeo & Geraghty, 2018; Hardy et al., 2016).

Implications of findings

The importance of maximising learning opportunities from clinical placements, as well as supporting students who are away from the university campus and support systems, is well established (Levett-Jones et al., 2018). The present review has identified a variety of technological strategies that may be used to support these purposes as well as considerations for their usage. In the course of the present review, it was noted that there was no standardised tool or set of points to evaluate use of technological strategies. A standardised tool would facilitate collation and comparison of strategies among the largely qualitative data set. When selecting technological strategies to support students during clinical placement educators should give consideration to: (i) the purpose that underpins the strategy; (ii) potential barriers to implementation such as connectivity and ease of use; and (iii) potential additional impact on student workload during clinical placements. Educators should ensure clarity regarding what is required of students, provide opportunities for students to engage and practise prior to placements, and be cognisant of their own potential impact on effectiveness of the selected strategy.

STRENGTHS AND LIMITATIONS OF THE REVIEW

The review was conducted in accordance with a peer-reviewed BEME protocol to provide structure and rigour to the review. The review team have a wide range of expertise as well as a variety of clinical and academic experience. Several of the team have been involved in Cochrane systematic reviews. A specialist subject librarian was recruited to the team in order to refine the search strategy and assist with the search process. Finally, one member of the review team was involved in all appraisal decisions to ensure consistency of approach. There are, however, some limitations to the present review. The assessment of a study's quality and strength of findings may be regarded as subjective, despite the use of assessment tools and the lead reviewer being involved in all decisions for consistency purposes. There is the potential that studies were missed, despite the comprehensive search strategy and the involvement of a subject specialist librarian, due to variations in terminology for clinical placements and technological strategy. There is also the potential that the review has been impacted by publication bias, that is, the failure to publish studies based on the direction or strength of findings (Dickersin & Min, 1993).

CONCLUSION

In light of the COVID-19 pandemic, it is important for educators to have an appreciation of interventions that support the learning experience of undergraduate health-related profession students during clinical placements. The present review provides insight into technological strategies employed for this purpose pre-pandemic, which may be adopted in order to provide support for student learning in an environment rendered increasingly stressful by the ongoing pandemic. The technological strategies within the present review facilitate the provision of student support without face-to-face engagement and as such may be regarded as resilient to challenging circumstances such as the COVID-19 pandemic. The review included 21 studies of mostly mixed methodology, however none were identified as being of high quality. Therefore, further research is required to provide stronger evidence to support their use by students during clinical placements. A range of interventions were noted, including blogging, chatrooms, wikis, messaging platforms and videoconferencing systems. The strategies purport several learner benefits, however as the majority of studies involved qualitative methodologies the benefits are not evidenced in terms of academic improvement. However, the reported learner outcomes are valuable for supporting the student learning experience during placements, and include improved clinical knowledge, increased reflection upon practice, increased peer and staff support, and reduced sense of isolation during placements. The main barriers to implementation are lack of clarity of the strategy purpose or what is required of the student, additional workload and time required of the student and the potential for technological difficulties to occur. As the technological landscape continues to evolve in response to the COVID-19 pandemic, academics will need to adapt to make best use of available resources to support the student learning experience during clinical placements.

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The authors report no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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