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Innovation in Teaching and Learning in Health Higher Education

Literature review

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Innovation in Teaching and Learning in Health Higher Education is a project led the Council of Deans of Health in partnership with the Higher Education Academy. The project is governed by an Advisory Group with representation from both organisations.

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Foreword

The landscape for health professional education is changing. The higher education (HE) sector faces the challenge of delivering high quality education at a time of financial constraint and increased emphasis on the student as a consumer. But universities also face new expectations from a health sector that is increasingly recognising both the inter-dependency between the quality of health care and the quality of education and training and the potential for education to support innovation. Although the differences in the HE and health policy context across the four UK home nations are increasingly significant, these are common challenges for all 85 members of the UK Council of Deans of Health.

New and imaginative approaches to the ways in which students learn are central to responding to these challenges. However, innovation in teaching and learning is all too often overlooked as an area of research or of policy focus. We were therefore delighted that the Higher Education Academy agreed to sponsor a one year project (extended to two years) to identify and disseminate curriculum innovations currently in practice across the UK in nursing, midwifery and AHP education. Now one year in, the project aims to provide a forum for universities to disseminate their innovative practice to a wider audience in HE and for the sector to showcase this innovation to healthcare providers and policymakers who shape the context in which health education is delivered.

The project's first year focused on scoping and identifying innovations, developing a student journey to provide a framework on to which innovation could be mapped. However, as we started to design our case study collection, it became clear that there are relatively few surveys of the existing evidence on innovation in health higher education. We therefore commissioned this literature review, which covers nursing, midwifery, the allied health professions and medicine, with the hope that it would complement our data collection and give an international context to the case studies we have collected. Given that innovation is as much about the culture that allows it to flourish as it is about the specific intervention, we also asked the team to look at barriers and enablers to innovation.

The literature review throws up many interesting findings. It is striking that there is relatively little research evidence on assessment or practice oriented innovative teaching and learning interventions, nationally or internationally. So too, the gaps revealed in the evidence base around the culture of innovation are something that we will pursue as a project group with a further literature review in 2014. However, the literature review reveals a rich body of research, covering areas as diverse as simulation, social media, drama and peer learning. Our hope is that the findings will help colleagues across the UK to track down the research evidence behind existing innovative practice and that it will stimulate many new ideas as we seek to continually improve the way we teach.

Professor Brian J Webster

Assistant Dean, Edinburgh Napier University and Chair, Innovation Project Advisory Group

Executive summary

Background

The Council of Deans of Health and the Higher Education Academy project aims to 'Scope and identify a range of teaching and learning innovations currently in practice across the UK within the education of healthcare professionals'. This literature review was undertaken, as part of this project, in order to locate and report on current published examples of innovative practice in teaching and learning in health higher education.

Review questions

1. What conceptualises and defines innovation in healthcare higher education?
2. How are cultures of innovation developed?
3. What evidence of innovation exists?
4. What are the barriers and enablers to innovation development and dissemination in healthcare higher education?

Method

The literature review was undertaken systematically, using a protocol-based approach between 20.05.13 and 19.07.13. Only primary or secondary research data were included in the review. Databases and search terms were pre-specified and literature published between 2010 and 2013 was retrieved. Papers were screened at title and abstract against exclusion criteria and eligible papers were included in the review.

Results

Data were organized and displayed through a student journey framework, described by the Council of Deans of Health in 2013. These included the presentation of six matrices with data displaying technological and non-technological innovations for medical, nursing and allied health professions.

Discussion

The review revealed a plethora of examples of innovative practices in healthcare higher education, predominantly in the USA, with far fewer examples from the UK. There appears to be a gap in the available evidence base relating to specific innovative practices in learning and teaching in higher education, particularly regarding enhanced student experience and sustainable student outcomes. It is likely that some innovative practices have not been researched or published and therefore they lack diffusion and adoption across the sector. Further exploration of definitions and cultures of innovation is recommended.

1. Introduction

The purpose of the literature review was to scope and identify existing good practice including the examination of definitions, cultures and diffusion of innovation in teaching and learning, and thereby raise the profile of healthcare education in the UK. Research was therefore required in order to map out the current position and offer a discursive synopsis of the area being examined. In line with the other aspects of the project, the approach to the literature review was to organize and display data through the student journey, from recruitment to employment, including undergraduate and post-graduate level training and education across practice and academic settings, as described by the Council of Deans for Health in 2013.

The Francis Report (2013) identified a number of recommendations to improve health care services and education for health care practitioners was among them. Establishing lifelong learning in the healthcare workforce is as important as raising the standards and quality of care. This is done through evidence based practice and is influenced by engaging students in innovative and effective research-informed teaching and learning (Willis Commission, 2012; Francis, 2013). The Department for Business Innovation and Skills (2011) called for a renewed focus on high-quality teaching in universities so that it has the same prestige as research. The need for innovation in teaching and learning in healthcare higher education has never been greater. This review is therefore extremely timely and offers an overview of current evidence based innovation in learning and teaching in healthcare higher education, both nationally and internationally.

2. Concepts and definitions of innovation in healthcare higher education

Innovation is difficult to define and there are several definitions of innovation in the literature. Consequently, student, individual and institutional perceptions and interpretations of innovation are subjective and vary. Practice that may be viewed and described as innovative by one student group or institution may be common place in another. However, since innovative practice is time bound and operating within a rapidly changing environment, it may be viewed as both innovative and common practice simultaneously, across institutions.

The 'Innovation in Learning and Teaching in Higher Education' project defined innovation as:

'Doing something new in teaching and learning for nursing, midwifery and allied health, in pre- and post-registration, undergraduate or post-graduate courses. This could include recruitment, widening participation, retention and pastoral care, curricula and course development and design, applications of technology, management skills and institution structure, changes to the culture and process of innovation, or improving future employability of students.'

And as:

'a new, sustainable approach that has led to an overall improvement in the student experience, and which is supported by evidence.'

A further definition was offered by Carpenter (2012). Carpenter explored definitions of the term 'innovation' and found that they fell within five themes. These were creativity, unmet user needs, problem solving, business models and applied invention. His work led him to the following definition of innovation:

'A change in a product offering, service, business model or operations which meaningfully improves the experience of a large number of stakeholders'

3. Review Questions & Protocol

3.1 Review questions

1. What conceptualises and defines innovation in healthcare higher education?
2. How are cultures of innovation developed?
3. What evidence of innovation exists?
4. What are the barriers and enablers to innovation development and dissemination in healthcare higher education?

3.2 Review protocol (PICOS)

	Inclusion	Exclusion
Population	Students and practitioners engaged in medicine, nursing, midwifery and allied health professional practice. Higher education setting.	Non-healthcare education. Primary or secondary education. Further education.
Intervention	Technological and non-technological innovations relating to: recruitment and admissions, learning, teaching and assessment, practice placement and career and employment.	Standard and non-innovative practice and interventions.
Comparator	None	None
Outcomes	Social media, digital devices, online and e-learning, simulation, virtual learning environments, learning, teaching and assessment approaches, recruitment initiatives, student support strategies, clinical practice innovations	
Study	International research papers, published in English, between 2010-2013	Non-research literature. Research papers dated prior to 2010

4. Literature review methodology

The literature review was undertaken in a systematic way using processes and techniques located in the York Centre for Reviews and Dissemination's guidance for undertaking reviews in health care (CRD, 2009) and the Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (Higgins, 2011). A comprehensive, protocol based approach was taken to search for, and retrieve relevant papers based on pre-specified inclusion criteria. Key points were displayed in matrices and summarized through a discussion.

4.1 Search methods

Text words and index terms were gathered from existing collections and from an initial scope of the literature using both Cinahl and Eric databases. This search strategy was then considered and modified. It was decided to not limit the search by naming particular innovative teaching strategies (for example team-based learning) so those terms were removed from the search. After a further scoping exercise it was decided to limit the search to 2010-2013. The language was restricted to English.

The following databases were searched:

- Medline (Ebsco)
- Cinahl (Ebsco)
- BEI
- ERIC
- ASSIA
- Index to Thesis
- OpenGrey

The search strategy was used to search Cinahl (Ebsco) and was adapted to search the other databases (Appendix 1).

4.2 Searching other resources

The following resources were searched for relevant information using the review inclusion criteria: OpenGrey for conference proceedings, Index to Theses, Higher Education Academy website, Joint Information Systems Committee UK website and the Association of Learning Technologists website.

4.3 Selection of studies

Inclusion and exclusion criteria

Study selection was undertaken using the pre-specified inclusion and exclusion criteria generated from the review protocol (PICOS). Titles and abstracts of retrieved studies were examined systematically by one review author, with a second review author examining borderline papers to determine eligibility for inclusion against the inclusion criteria. The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) template was used to record the literature search and selection as a mechanism for promoting transparency and creating an audit trail (Appendix 2).

Quality assessment

The quality assessment criteria applied within this review involved the exclusion of all papers that were not either primary or secondary research. This was done to ensure that the best available evidence was used.

4.4 Data extraction and aggregation

Data were extracted using a data extraction matrix designed specifically for this review. Data were extracted and checked by two review authors using the same data extraction matrix, which was piloted beforehand. A third review author was available to resolve any differences in opinion by the two review authors regarding extracted data. The clear inclusion criteria reduced ambiguity and therefore arbitration was not required. Data were extracted from the following domains: professional group(s) and student journey stage, author, country and date of publication, innovative intervention and type of innovation. Six data matrixes were developed to display data from the following categories: Medical technological innovations, Medical non-technological innovations, Nursing technological innovations, Nursing non-technological innovations, Allied health professions: technological innovations, Allied health professions: non-technological innovations (Appendix 3-8). Data were aggregated and displayed in one of six themed matrices (Appendix 3-8). Patterns and trends across each matrix were identified and discussed in an annotated bibliography.

5. Evidence of Innovation: annotated bibliography

5.1 Medical technological innovations in teaching and learning in healthcare higher education

The reviewed literature associated with technological innovations in the teaching and learning of medical students in healthcare higher education related to simulation, digital teaching aids, online teaching and assessment, e-learning, virtual learning environments, and the use of social media. As there is no standard definition of these interventions, they were categorized in terms of how the original author described them. The implementation of these innovations in the context of the 'student journey' was found in both undergraduate and post-graduate courses. There were no examples of medical oriented technological teaching and learning innovations at pre-commencement and enrolment. Papers were predominantly from the USA and Canada, with some indication of such innovations being researched within the UK and Europe.

Simulation

The most prolific examples of medical oriented technological teaching and learning innovations in the reviewed literature was simulation. Simulation tended to be geared towards both the development and consolidation of physical health knowledge and skills or communication skills, at undergraduate level.

In relation to teaching psychological health interventions, Lefroy et al (2011) prepared first year medical students to respond to patients' emotions effectively through the use of a simulated patient technique. Similarly, Bonnaud-Antignac et al (2010) addressed effective methods in disclosing cancer to patients with a Six Point Protocol (SPIKES) and group discussion. Other examples of the use of simulation with undergraduate medical students (alongside chaplaincy, social work and nursing students) included online interactive simulation used to teach spiritual and cultural dimensions of palliative care (Ellman et al, 2010). Mura et al (2013) described the utility of simulated learning as an approach targeting undergraduate psychiatrists in psychotherapy.

Simulation through the use of Sim Man for final year medical students was described by Paskins et al (2010), with Kreiter et al (2011) using a novel computer-based approach designed to formatively assess second year medical students' ability to undertake diagnostic laboratory tests. Another example of simulation used to assess clinical examination skills amongst undergraduate medical students was the use of the VentriloScope which simulates auscultatory findings (Verma et al., 2011). Medical device training through simulation was further described by Westwood et al (2012) and Helle et al (2011). Hale et al, (2011) described simulation techniques used to teach intravenous catheter placement to medical students as a component of an intravenous cannulation education module.

An example of the use of simulation as an innovative approach to teaching and learning amongst both undergraduate and post graduate medical students was the use of a critical care

ultrasonography workshop (Sekiguchi et al, 2013). This intervention was delivered as a blended learning approach using a web-based learning programme and simulation.

Digital teaching Aids

The use of digital teaching aids was described by several authors. For example, a novel Three-Dimensional Tool for teaching human neuro-anatomy to first year medical students during their course was described by Estevez et al (2010). Whilst van Hell et al (2011) employed the use of a digital pen to assess the clinical performance of medical students. Other examples of the use of digital teaching technology was the use of audience response systems used to evaluate performance, with student plastic surgeons and digital tools used in combination with simulation (Halle et al, 2012).

An example of a digital teaching aid used with post graduate medical physicians was telesimulation. This was an innovative tool for teaching intraosseous insertion techniques in developing countries (Mikrogianakis et al, 2011).

Online/e-learning teaching and assessment

Examples of online teaching and assessment techniques targeting post graduate medical practitioners were Branzetti et al (2011) who introduced an online didactic curriculum with medical residents and Diehl et al (2013) who introduced a game designed to improve insulin initiation and adjustment (InsuOnline). Another example of innovative online post graduate medical education, aimed at primary care practitioners was published by Allaire et al (2011). This was a novel approach to improving decisions about antibiotic prescribing for respiratory infections, known as DECISION+.

An online assessment tool targeting both undergraduate and post graduate medical students was described by Balayla et al (2012) to assess students on surgical procedures. Edirippulige et al (2012) described an online eHealth course combined with 'hands on practicum' aimed at undergraduate and post graduate medical students.

There was evidence of e-learning amongst undergraduate medical students in the reviewed literature. Video iPods were included in undergraduate medical education by Hansen et al (2011), with Jalali et al (2011) using podcasting as an e-learning tool. Chan et al (2010) described a blended approach to learning and teaching by the integration of 'video trigger' in problem based learning.

Virtual learning environments

Virtual learning was described by three authors in the literature. Lovquist et al (2012) used a virtual reality-based training system to teach medical students about spinal anaesthesia. Whilst Tam et al (2010) used 'Disect', a computer programme, with third year medical students to strengthen knowledge related to anatomy. An online interactive approach was taken by McEvoy et al (2012), through the use of the virtual patient, with medical undergraduate students.

Social media

Only one example of using social media directly with undergraduate medical students was located in the reviewed literature. Bahner et al (2012) described the use of 'high-yield ultra-sound concepts', which were posted daily to Twitter@EDUltrasonnd, administering tweets to medical students' mobile devices.

However, smartphones were reported by Ozdalga et al (2012) as social media designed to improve patient care and communication amongst medical students and practitioners. Whilst Paton et al (2011) reported the use of social media through online tools with undergraduate and post-graduate medical students to promote collaboration amongst health professionals.

5.2 Nursing technological innovations in teaching and learning in healthcare higher education

A similar number of papers reported on technological innovations in nursing teaching and learning in higher education as were reported in relation to medical students. Studies undertaken in the UK however, were better represented in this group of papers. Technological innovations in nursing education were reported from a wide global perspective, with papers from Australia, Taiwan and Egypt, in addition to the UK, USA and Canada offering interesting insights. Technological innovations in nursing were categorised in the same way as those in medical education. These were simulation, digital teaching aids, online teaching and assessment, e-learning, virtual learning environments and social media including mobile technologies.

Simulation

Introducing simulation into the teaching and learning experiences of student nurses was reported from several countries including the USA, Australia, Canada and the UK. This included a systematic review of quantitative studies of simulation-based learning in nurse education (Cant and Cooper, 2010). Individual examples included Smith and Barry (2013) who reported on a simulation activity to teach elderly diabetic care to nursing students during their course; Bowden, et al. (2012), who used a combination of simulation sessions with online video records and online feedback to teach cardiopulmonary resuscitation and Jenson and Forsyth (2012), who reported their experience of introducing a virtual reality simulation exercise into their curriculum for nursing students during their course.

Digital teaching aids

A wide variety of digital teaching aids were used across the student journey through nurse education. These included the use of online video in clinical skills education of oral medication administration (Holland et al, 2012); using photovoice to enhance engagement and learning through reflection (Leipert and Anderson 2012); videoconferencing between classroom and clinical area (diabetic clinic), (Rush, et al 2011); podcasting, (Vogt et al, 2010), integration of an audience response system within lectures (Lee and Dapremont, 2012) and a literature review on using audio response systems (Mareno et al, 2010). Whilst mobile devices were used in some of

these studies for their potential to be used as student response systems and podcasting, Clay (2011) reported their use for the acquisition of clinical skills in post registration nurse education.

Online/e-learning teaching and assessing

Online teaching initiatives made up the greatest number of researched innovations in this group. For example, Gerdprasert, et al (2011), supplemented traditional teaching with a web-based learning resource for nursing students during their course.

Using online resources to support learning for post-registration (qualified nurses) seemed a popular innovation. For example, Heale et al (2010) supported a distance learning provision for post registration nurses with online resources; Halabisky et al (2010), introduced an e-learning resource for their post registration nurses; Anderson and Enge (2012) reported on using technology-supported resources for teaching practice nurses on a post-registration programme and Chang et al (2011) discussed e-learning systems within hospitals, designed for qualified nurses.

There were instances of authors comparing traditional approaches to teaching and learning with online/e-learning provision, for example Bloomfield, et al (2010), conducted a randomised controlled trial comparison of e-learning and tradition methods of teaching hand-washing to first year nursing students, whilst Abdelaziz, et al (2011) conducted a comparative evaluation of the effect of electronic learning and traditional lecture style learning with their second year student nurses.

Virtual learning environments

There was little reported in terms of research into virtual learning environments. However, McCallum, et al (2011), reported on their experience of using a 'Second Life' clinical simulation laboratory to improve the decision making skills of nursing students during the third year of their course. There were no research based studies related to the use of social media in nurse education.

5.3 Allied health professions technological innovations in teaching and learning in healthcare higher education

Technological innovations in the provision of higher education for students in the allied health professions, was the least populated category. However, a full range of technologies were located across the student journey, with examples of work falling into the key areas of this review; simulation, digital teaching aids, online/ e-learning teaching and assessment and virtual learning. There were no examples of the use of social media being researched as an educational tool for this group of students. It appears from this analysis that technology for teaching and learning is predominantly being used in these professions for promoting practice skill development.

Reports were identified from a range of countries; the USA and Canada were the most represented, with some representation from Australia, South Africa and Hong Kong. Europe was represented by the UK, Germany and Sweden. Most of the allied health professions are represented in this review in some form. There are instances of inter-professional education being reported on, whereby several professions are learning together, for example Van Soeren et al (2011) and Solomon et al (2010) as well as reports related to single professions, for example Maloney et al (2011 and 2013) who report on their work with physiotherapy students.

Simulation

There were two American systematic reviews of simulation based education for students of the allied health professions; Rosen et al (2012) report on their systematic review of simulation in clinical practice settings, which involved health care professions at postgraduate level, whilst Cook et al (2013) report on their review of simulation based instruction among students in the health care professions. Harder (2010) reported on their experiences of simulation in teaching and learning with postgraduate students in the health care professions. Van Soren et al (2011) discussed simulated inter-professional education using video-recorded role-plays and debriefing sessions, which were delivered to undergraduate and postgraduate student health care professionals.

Digital teaching aids

A range of digital technologies were reported in relation to their use for teaching allied health professionals; most frequently related to practice-based learning. Maloney et al (2013) for example, reported on the use of videos to teach practical skills to undergraduate physiotherapists, whilst Lachman et al (2012) reported on the use of mobile devices for collecting data related to experience whilst on clinical practice. In a second paper Maloney et al (2013) reported on facilitating experiential practice and reflection on performance through student self-video, and exposure to peer benchmarks, suggesting that this may promote greater levels of skill competency. Mareno et al (2010) reported their use of audio response systems as an innovative approach to teaching and learning.

Online/e-learning teaching and assessment

There were a wide range of online/e-learning activities discussed in relation to students from the allied health professions. Eales-Reynolds et al (2012), for example reported on using an innovative web 2.0 tool for the development of critical thinking skills amongst nursing and health care students during their course. Maloney et al (2011) reported on a web-based innovation targeting physiotherapists, which trains them to prescribe exercises for falls prevention and Ghosh et al (2013) described an artificial intelligence system to train health care workers effective hand hygiene techniques. Harrison et al (2012) used an asynchronous online case discussion assessment tool to promote inter-professional learning and collaboration, whilst Maloney et al (2013) further reported on their online learning repository (Physeek).

Virtual learning environments

There were two instances of virtual learning environments being used innovatively by the allied health professions. These were Casteleijn et al (2010) who reported on the use of Blackboard as a learning management system with occupational therapy students, and Gordon et al (2010) who reported on planning e-learning materials for inter-professional education to promote collaboration and service user presence in the classroom. This initiative involved peer learning between physiotherapists, occupational therapists, nurses, sports and exercise sciences, radiography and social work students.

5.4 Medical non-technological innovations in teaching and learning in healthcare higher education

This was a large category of papers for review, matching equally in number those categorised under medical technological innovations. There was a similar spread in terms of country of origin, with the USA and Canada most prominent. A full range of innovations in learning and teaching for medical students, demonstrating the full student journey, was offered, although little in terms of recruitment. These incorporated clinical skill development, approaches to assessment and feedback, new ways of engaging students by active experiential approaches to learning and the adoption of reflection in the curriculum and/or new ways of supporting students to become reflective. To reflect the student journey, these innovations will be reported under the headings: new teaching and assessment methods - university and new teaching and assessment methods - practice placement

New teaching methods - university

By far the most frequently reported non-technical innovation for teaching medical students related to new ways of engaging students in the learning process. These included several instances of drama being introduced into the curriculum, with professional actors to support role play. For example, Sutin et al (2011) introduced actors to role play older adults; Reilly et al (2012) used theatre in their teaching to increase empathy and Koponen et al (2011) used theatre, simulated patients and role play to teach interpersonal communication competence. Examples of using art and drama in medical student learning came from the USA, the UK, the Netherlands, Finland and New Zealand, indicating diffusion of innovation through universal adoption of this approach.

Other ways of engaging medical students through experiential learning included varied curriculum changes based on active learning strategies, such as those discussed by Besdine et al (2011). There were several examples of peer learning reported, for example, Chinnah et al (2011) reported the outcomes of involving students in peer physical examinations and palpation for teaching human anatomy; Kam et al (2013) reported on a structured revision programme including peer-assisted learning and Taylor et al (2013) introduced peer mentorship in teaching clinical skills.

There were several examples of innovative approaches to including service users and carers in the learning experiences of medical students. These included teaching students about obesity through longitudinal relationships with bariatric surgery patients (Roberts et al, 2011); a novel hospital visitation programme involving kindergarten children in the teaching of clinical paediatrics (Pharm et al, 2010) and survivors (patients) teaching students with a view to increasing awareness about ovarian cancer (Fitch 2011).

Several authors reported innovations in assessment; these included Ross et al (2012) who developed a competency-based achievement system of assessment; Dory et al (2010) who discussed the development of an authentic assessment instrument for use in summative assessment; an assignment that was designed based on the Ask, Acquire, Appraise and Apply steps of evidence-based practice, and Kassab and Hussain (2010) who introduced concept maps as a method of assessment in problem based learning. Hetteema et al (2012) reported on the development of a performance feedback tool to build learner confidence. Abdelkhalek et al (2010) reported on their experiences of delivering team based learning as preparation for problem based learning.

There were also examples of blended learning being evaluated in the literature, for example, Thompson et al (2011) discussed the delivery of an initial e-learning module and a subsequent practical component, whilst Davidson (2011) discussed a blend of curriculum changes including team based learning and online learning modules.

New teaching and assessment methods - practice placement

It was interesting to note that reflective learning which featured prominently in the literature, related to innovation in medical student education. Reflection has long been an accepted and integrated part of the curriculum in the cases of nursing, midwifery and other allied health professions, and was not reported as frequently as an innovation in those professions in this review. However, Hudson et al (2012) reported having introduced a clinical log as part of a medical student learning portfolio, aiming to develop a habit of critical reflection, whilst Aronson et al (2011) discussed their development of a literature-based reflective writing guide. Attar et al (2011) reported on the development of a logbook for recording and analysing ideas in practice; de Feijter et al (2012) reported the outcomes of a patient safety course based on reflective learning and personal experiences and Vivekananda-Schmidt et al (2011) discussed their evaluation of teaching medical students reflective skills.

Two authors reported on the benefits of peer-assisted learning; Taylor et al (2013) reported on peer mentorship in teaching clinical skills and Kam et al (2013) introduced a structured revision programme including peer-assisted learning in the curriculum.

5.5 Nursing non-technological innovations in teaching and learning in healthcare higher education

The majority of non-technological innovations in nursing related to new training and teaching techniques used within the universities and a range of novel and creative approaches were located in the literature. Interestingly, these mirrored the interventions reported in medical education, with an introduction of art and theatre, service user involvement and activities to encourage student engagement making prominent appearances. Examples tended to centre on students during their undergraduate course. However there was one example of an innovation related to pre-commencement, enrolment and widening participation. This was an initiative led by Rhodes-Martin et al (2010), who developed a course entitled 'Portfolio of Evidence for Entry to level one study', to enable potential nursing students the opportunity to demonstrate numeracy and literacy skills.

New teaching methods - university

Interventions to teach clinical judgement skills were reported in two papers. These were Gerderman et al (2013), who described the use of concept mapping to teach clinical judgement skills and Lindsey et al (2013) who designed and described a novel intervention using clinical simulation.

Service user involvement in nursing education was also reported in two papers. These were Terry (2012) and similarly Bryne et al (2013) describe involving service users with mental health experiences to illustrate challenges through a lived experience.

High fidelity simulation in teaching and assessing (Burns et al, 2010) received a high profile in the literature and was used to increase student confidence and clinical competence (Blum 2010); Zavertrnik et al (2010) used simulation to improve communication skills. The utility of simulation as a vehicle to teach health care ethics was also highlighted by Haddad (2010). Kelly et al (2013) used authentic scenarios for simulation with post-graduate students.

Arts-based learning was used as a creative teaching method at undergraduate level by Rieger et al (2013) and as a skills assessment intervention alongside visual training to improve clinical observational and diagnostic reasoning skills by Pellico et al (2012). Autry et al (2011) introduced artistic representation as a mechanism to encourage creativity and self-reflection, whilst Meng et al (2011) introduced interactive theatre to teach conflict resolution skills to postgraduate students.

Reflection was also located in the literature as a teaching method designed to promote empathy amongst undergraduate nursing students (Webster 2010) and to enable students to cope with emotionally challenging situations (Rees 2013). Lillyman et al (2011) adopted a storyboard technique to promote deeper reflection amongst undergraduate nursing students learning about end of life care, whilst Savage et al (2011) employed an 'adaptive reflection' process as a new teaching method.

Further innovations to increase student engagement included interventions by McCurry et al (2010), who adopted active learning assignments and quizzes as a strategy to teach research to undergraduate nursing students, and McLafferty (2010) who described using gaming workshops as a novel method used to teach nursing students to care for older adults. Team-based learning (Sisk, 2011), problem-based learning (Chan, 2012) and peer learning (Chojecki, 2010) were also reported as innovative teaching approaches at undergraduate level. However, Vittrup (2010) used problem based learning with post graduate students.

New teaching and assessment methods - practice placement

Innovations related to teaching methods and support and training in clinical practice tended to centre on undergraduate students during their course with some evidence of postgraduate initiatives. Examples included concept map care planning (Karns et al, 2010), peer learning partnerships (Christiansen et al, 2011), critical thinking processes (Lechasseur et al, 2011), a spiritual care visit to Lourdes (Baldacchino, 2010), simulation (Buykx, 2011) and peer mentoring (Sims-Giddens et al, 2010).

Examples of postgraduate support and training in practice included a novel approach to respiratory assessment (Duff et al, 2012), partnership working through action research (Crozier et al, 2012), personal resilience development in participatory learning groups (McDonald et al, 2012), team learning (Timmermans et al, 2012), appreciative inquiry in paediatric oncology (Lazic et al, 2011), and preceptor profiling through interpretation of experiences and challenges.

Evans et al (2010) designed the 'Putting Knowledge to Work Framework'; a re-contextualisation approach to nurse education, targeting both pre-registration and postgraduate nurses in clinical practice.

5.6 Allied health professions non-technological innovations in teaching and learning in healthcare higher education

This was a small category of research papers, which contained one literature review of inter-professional learning (Abu-Rish et al, 2012) and a wide range of single interventions aimed at improving core values such as communication skills, for example, Hayward and Blackmer (2010) and Johnston et al (2012). Most of the papers referred to interventions that had included two or more professions learning together, for example McClelland and French (2011) involved third year student midwives and second year student paramedics in peer assisted learning techniques, to support the development of teaching clinical skills.

New teaching and assessment methods-university and practice placement

Three papers referred to teaching and learning interventions for particular allied health professions. These were Obrez et al (2011) who reported on a change of delivery mode to increase active experiential learning for dentistry students, Rubin et al (2011) who introduced

appreciative inquiry as a new method of delivery in occupational therapy education and Rapport et al (2010) who reported on a particularly innovative approach to involving service users and carers in their physiotherapy curriculum; students were paired with community volunteers who had a self-identified physical disability. Each student followed his or her volunteer throughout the three year curriculum, learning about life with a disability directly from the volunteer's and family's perspectives and experiences.

A number of papers referred to inter-professional learning based on skills for professional practice. Of particular note was the work of Shiyabola (2012) who introduced a student-led inter-professional innovative health promotion model with diabetic patients; this American study involved students from five of the professions allied to health. Similarly, Warner et al (2010) reported on how nursing and podiatry students were invited to attend the established university clinic and undertake assessment tasks relevant to their profession as well as learn and practice clinical skills outside their usual professional practice.

It is evident in the other categories of papers that those who report on innovations to the mode of delivery are all moving towards some form of active experiential learning aimed at achieving greater student engagement with the learning experience. An example here is the work of Hayward and Blackmer (2010) who introduced a delivery mode that included standardized patients, online communities of practice and reflection to engage their medical and physiotherapy students in learning together.

Also reflecting other categories, it can be seen that most of the researched innovations to have been identified in this literature review are from the USA. However, there are interesting examples from Australia and Europe, with the UK being represented in only one paper, which related specifically to occupational therapy students.

6. Cultures of innovation

Innovation requires more than just new ideas. It needs the kind of culture that is conducive to sustainable innovation, one that enables innovation to become part of an organisations internal structure. Whilst many higher education institutions recognise the relationship between culture and innovation and have training programmes in place to convey vision and value statements to provide staff and managers with a guide to practice, there was very little in the literature to reflect either the impact of culture on the innovation, the approach to change management or the role of the institution in supporting or sustaining the innovative practice. How cultures of innovation are developed or sustained was not captured in the scope of this review.

6.1 Barriers and enablers to innovation development and dissemination in healthcare higher education

The papers considered in this literature review did not elucidate any key factors that could be reported under this heading, referring to barriers or enablers to innovation. However, it was noted that there were fewer papers from the UK reporting on evidence based innovation in learning and teaching in healthcare education than had been anticipated. It might be assumed therefore that this review does not reflect fully the amount of innovative practice that is taking place in these disciplines across the UK. However, it does perhaps indicate that staff delivering health care higher education in the UK, who may well be introducing innovative approaches to teaching and learning and disseminating this through conference presentations and journal publications, are not systematically evaluating the impact of their innovation.

Without further study and investigation it is only possible to speculate on the reasons for this. One likely factor is funding; there is not a huge amount of money available in the UK to support pedagogic research. The Centres for Excellence, funded by HEFCE between 2005 and 2010 for example, focussed on educational development and some were based on the health professions, yet their presence was not noted in this review of evidence based innovation in teaching & learning. Another possible reason, particularly in the professions allied to health, nursing and midwifery, is that the critical mass of teaching staff are yet to gain doctoral qualifications and thereby the skills and confidence for undertaking evaluation of their own practice. A culture of evidence-based education practice may still need to be developed in many Schools of Health within the UK.

7. Conclusion

The review highlighted a wide range of examples of innovation using the structure of the student journey from recruitment to employment, including undergraduate and post-graduate level training and education across practice and academic settings. Extensive evidence of innovative practices in teaching and learning for students in healthcare higher education was reported. Whilst the literature review has enabled trends to be identified, it has also shown gaps in the evidence base for some practices. Additionally, there does not appear to be a standard definition of what innovation is in this context, nor how cultures of innovation are developed.

In terms of technological innovations there was similar representation across medical and nursing healthcare higher education, with less evidence from the allied health professions. Non-technological innovations were found predominantly within nursing, with a significant volume of evidence in medical education and considerably less in the allied health professions. The most commonly reported innovation was simulation and this was delivered as a technological and non-technological intervention as a teaching and learning approach. There were only a few assessment or practice oriented innovative teaching and learning interventions located in the papers across all professional groups. The majority of the innovations were delivered in undergraduate education and training with less in postgraduate, despite there still being a large volume of evidence of innovation in postgraduate education. There were gaps in the literature reviewed relating to innovation focusing on pre-enrolment and post course and employability.

The initial retrieval of research papers screened, suggested that there would be a large volume of information to process. However, the majority of the information was rejected as it was not research. Therefore, it appears that there is a substantial range of innovative practices being implemented in healthcare higher education that is not widely recognised as it lacks evaluation and subsequently adoption across the higher education sector.

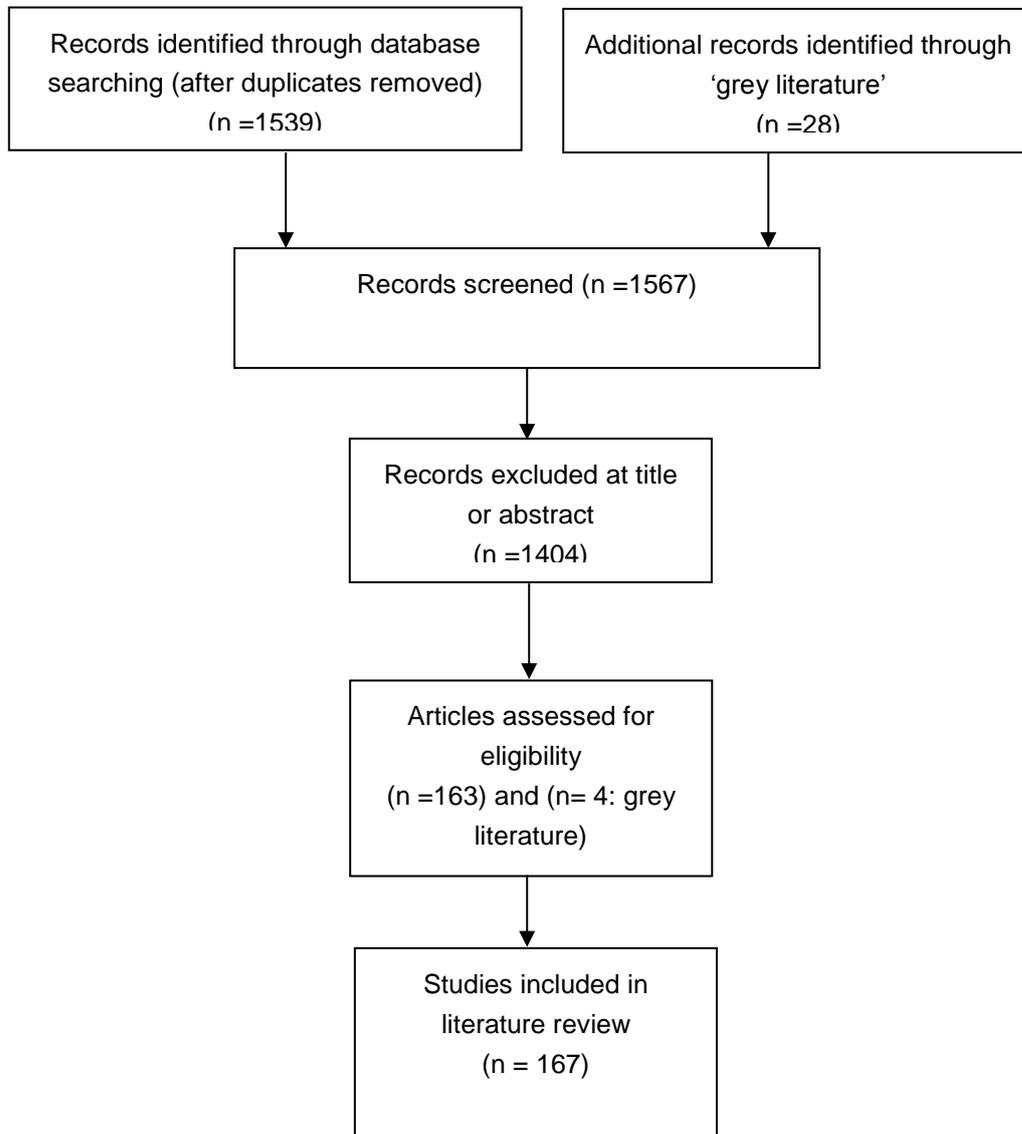
Appendix 1: Search strategy

The following is the specific search strategy used in Cinahl and was applied to the other databases

S58	S54 AND S55 AND S56
S57	S54 AND S55 AND S56
S56	S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42
S55	S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25
S54	S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 OR S52 OR S53
S53	"best practice"
S52	"cutting edge"
S51	"leading edge"
S50	"originality"
S49	"original"
S48	creativ*
S47	"innovative"
S46	(MH "Diffusion of Innovation")
S45	"innovation"
S44	"novel"
S43	innovat*
S42	(MH "Student Selection")
S41	(MH "Student Recruitment")
S40	(MH "Learning Methods")
S39	(MH "Students, Graduate") OR "post graduate"
S38	(MH "Teaching Methods")
S37	programme
S36	course*
S35	higher education
S34	teach*
S33	training
S32	learning
S31	educat*
S30	curriculum
S29	college*
S28	universit*
S27	under-grad*
S26	undergrad*

- S25 (MH "Students, Pharmacy")
 - S24 (MH "Students, Occupational Therapy")
 - S23 "radiography students"
 - S22 (MH "Surgical Technologists")
 - S21 (MH "Students, Podiatry")
 - S20 (MH "Students, Audiology")
 - S19 (MH "Optometry")
 - S18 (MH "Students, Medical")
 - S17 (MH "Students, Dental")
 - S16 (MH "Health Occupations+")
 - S15 (MH "Nurses+")
 - S14 (MH "Allied Health Personnel+") OR (MH "Allied Health Professions+")
 - S13 (MH "Health Personnel+")
 - S12 (MH "Physical Therapists")
 - S11 therap*
 - S10 physiotherap*
 - S9 (MH "Nurses")
 - S8 nurs*
 - S7 "health professional"
 - S6 (MH "Students") OR "students" OR (MH "Students, Physical Therapy") OR (MH "Students, Midwifery") OR (MH "Students, Nurse Midwifery") OR (MH "Students, Nursing, Associate") OR (MH "Students, Nursing") OR (MH "Students, Allied Health") OR (MH "Students, Radiologic Technology") OR (MH "Students, Health Occupations")
 - S5 S1 OR S2 OR S3 OR S4
-
- S4 "mixed methods"
 - S3 (MH "Research")
 - S2 "quantitative"
 - S1 (MH "Qualitative Research")

Appendix 2: PRISMA Flow Diagram



Adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009), Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097.

Appendix 3: Medical: technological innovations

Professional group(s) and student journey stage	Author, date of publication and country	Innovative intervention	Technological innovation type
Primary care physicians, postgraduate	Allaire et al (2011), U.S.A	DECISION+, a continuing medical education program for optimizing decisions about antibiotics for acute respiratory infections in primary care	Online/e-learning teaching and assessment
Medical students, during course	Bahner et al (2012), U.S.A	Curriculum consisting of high-yield ultrasound concepts was developed and posted to Twitter @EDUltrasonnd daily. Followers received tweets 'pushed' directly to their mobile devices	Social media
Medical students and residents, during course and postgraduate	Balayla et al (2012), Canada	Surgical procedural knowledge (SPK) assessment tool	Online/e-learning teaching and assessment
Medical residents, postgraduate	Branzetti et al (2011), U.S.A	Online didactic curriculum	Online/e-learning teaching and assessment
Medical students, 5 th year, during course	Bonnaud-Antignac et al (2010), France	Group discussion and taught 6 point protocol (SPIKES), videotaped simulated assessment in disclosing cancer diagnosis to patients, feedback on performance	Simulation
Medical students, during course	Chan et al (2010), China and Scotland	Video trigger in problem-based learning	Online/e-learning teaching and assessment
Medical students, during course	Clayton et al (2013), Australia	Individual sessions with a facilitator and simulated patient. Participants received written and audio-visual take-home learning materials and were videotaped to improve communication	Online/e-learning teaching and assessment and simulation
Primary care physicians, postgraduate	Diehl, Souza et al (2013), Brazil	InsuOnline, a game for education of primary care physicians to improve appropriate initiation and adjustment of insulin for the treatment of diabetes mellitus	Digital teaching aid
Medical students	Edirippulige et al (2012),	Hands-on Practicum to Supplement an online eHealth course	Online/e-learning

during course and postgraduate with chaplaincy, social work and nursing students	Australia		teaching and assessment
Medical students with nursing and social work students, during course	Ellman et al (2012), Diehl et al, (2013)U.S.A	Online interactive simulation used to teach spiritual and cultural dimensions of palliative care	Simulation
Medical students, 1 st year, during course	Estevez et al (2010), U.S.A	Novel three-dimensional tool for teaching human neuroanatomy	Digital teaching aid
General practitioner students, during course	(Gormley et al, 2011), Northern Ireland	IVIMEDS 'Riverside' authoring tool; online virtual patients.	Virtual learning environments
Medical students, during course	Hale et al (2011), U.S.A	Basic clinical skills training	Simulation
Medical students, during course	Hansen et al (2011), New Zealand	Video iPods	Online/e-learning teaching and assessment
Obstetric and neonatal nurses, during course.	Heitzler (2012), U.S.A	Two different online continuing education interventions on the cultural competence level of obstetric and neonatal nurses.	Online/e-learning teaching and assessment
Medical students' during course	Helle and Saljo (2012), U.S.A	Digital tools and peers in medical education: cases and simulations as interventions in learning	Simulation and digital teaching aids
Medical students, during course	Jalali et al (2011), Canada	Podcasting as an innovative asynchronous e-learning tool	Online/e-learning teaching and assessment
Medical practitioners, postgraduate	Jayawardena et al, (2011), U.S.A	Low-bandwidth web-conferencing. Enhancing dissemination of the Ponseti method in Latin America through virtual forums	Virtual learning environments
Medical students, 2 nd year, during course	Kreiter et al (2011), U.S.A	Novel computer-based medical case simulation for teaching and formative assessment of diagnostic laboratory testing	Simulation
Medical students, 1 st year, during course	Lefroy et al (2011), UK	Level of emotion expressed by a simulated patient in a teaching session designed to prepare students to handle emotions when interviewing real	Simulation

		patients on placements	
Medical students, during course	Lovquist et al. (2012), Ireland	Virtual reality-based training system for spinal anaesthesia	Virtual learning environments
Medical students, during course	McEvoy et al, (2012), Ireland	Online interactive virtual patient	Virtual learning environments and online/e-learning teaching and assessment
Medical physicians, postgraduate	Mikrogianakis et al (2011), Toronto and Botswana	Telesimulation: An innovative and effective tool for teaching novel intraosseous insertion techniques in developing countries	Digital teaching aid
Psychiatric trainees in psychotherapy, during course	Mura et al (2013), U.K	Innovations in simulated and technology-aided learning	Simulation
Medical practitioners and medical students, during course and postgraduate	Ozdalga et al (2012), U.S.A	Smartphone to enhance continuing medical education, patient care and communication.	Social media
Medical students, final year, during course	Paskins and Peile (2010), UK	Simulation based teaching using 'SimMan'	Simulation
Medical practitioners and medical students, during course and postgraduate	Paton et al (2011), U.S.A	Social media using online tools that allow collaboration and community building amongst health professionals	Social media
Medical physicians, during course and postgraduate	Sekiguchi (2013), U.S.A	A general critical care ultrasonography workshop; a novel Web-based learning program combined with simulation-based hands-on training	Simulation
Medical students, 3 rd year, during course	Tam et al (2010), UK	Computer program ('disect') to consolidate anatomy knowledge	Virtual learning environments
Medical students,	van Hell et al (2011), the	Digital pen as clinical performance assessment tool	Digital teaching

during course	Netherlands		aid
Medical students, 3 rd year, during course	Verma et al (2011), UK	The Ventriloscope as an innovative tool for assessing clinical examination skills: appraisal of a novel method of simulating auscultatory findings	Simulation
Medical students, during course	Westwood et al (2012), UK	Virtual worlds; an innovative tool for medical device training in a simulated environment	Simulation

Appendix 4: Nursing: technological innovations

Professional group(s) and student journey	Author, date of publication and country	Innovative Intervention	Technological innovation type
Nursing students during course, 2 nd year	Abdelaziz et al (2011), Egypt	Comparative evaluation of effect of electronic learning and traditional lecture style learning	Online/e-learning teaching and assessment
Practice nurses, post-registration	Anderson and Enge (2012), U.S.A	Technology supported resources	Online/e-learning teaching and assessment
Nursing students, during course	Alves et al (2010), USA	Evaluation of online learning materials	Online/e-learning teaching and assessment
Nursing students, during course – 1 st Year	Bloomfield et al (2010), U.K	Comparison of e-learning and traditional methods of teaching hand washing	Online/e-learning teaching and assessment
Nursing and medical students, during course	Bowden et al (2012), U.K	Web-based video and feedback in the teaching of cardiopulmonary resuscitation	Simulation
Nursing students, during course	Cant and Cooper (2010), Australia	Simulation-based learning in nurse education: A systematic review	Simulation
Nurses, postgraduate	Chang et al (2011), Taiwan	E-learning systems within hospitals	Online/e-learning teaching and assessment
Nursing students, during course	Clark-Burg et al (2010), Australia	Using video to enhance practical skills	Online/e-learning teaching and assessment
Post-registration nurses	Clay (2011), U.S.A	Mobile technologies for the acquisition of clinical skills	Digital teaching aids
Post-registration nurses	Davidson (2011), USA	Redesign of curriculum to include online resources and increased peer support	Online/e-learning teaching and assessment

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Nursing students, during course	Gerdprasert et al (2011), Thailand	Supplementing traditional teaching with a web-based learning resource	Online/e-learning teaching and assessment
Nursing students, during course	Giddens, J. et al (2010) U.S.A	Virtual community an online teaching application featuring a fictional community with multiple intersecting and unfolding character stories	Online/e-learning teaching and assessment
Nursing students, during course	Greenfield (2011), USA	Podcasting	Digital teaching aids
Post-registration nurses	Halabisky et al (2010), UK	E-learning resource	Online/e-learning teaching and assessment
Post-registration nurses	Heale et al (2010), Canada	E-learning/distance learning	Online/e-learning teaching and assessment
Nursing students, during course – 1 st Year	Holland et al (2012), UK	Online video in clinical skills education of oral medication administration	Online/e-learning teaching and assessment
Nursing students, during course	Hsu and Hsieh (2011), Taiwan	Blended modules on ethics course using web-based module: short videos showing examples of ethical dilemma professional nurses frequently come across, completed with a PowerPoint file	Online/e-learning teaching and assessment
Nursing students, during course	Jones et al (2011), Australia	Teaching critical appraisal skills for nursing research through combined face-to-face and online methods	Online/e-learning teaching and assessment
Nursing students, during course	Jenson and Forsyth (2012), USA	Virtual reality using simulation	Simulation
Registered nurses and care assistants	Lange et al (2011), USA	Tailored on-site education incorporating simulation	Simulation
Nursing students, during course	Lee and Dapremont (2012), USA	Integration of the 'Audience Response System' within lectures	Digital teaching aids
Nursing and health science students, 3 rd and 4 th year, during course	Leipert and Anderson (2012), Australia	Using photo- voice to enhance engagement , learning and reflection	Digital teaching aids

Nursing and health science students, during course	Mareno et al (2010), USA	Using 'Audio Response Systems'	Digital teaching aids
Nursing students, during course, 3 rd year	McCallum et al (2011), UK	'Second Life' clinical simulation laboratory, to improve decision making skills	Online/e-learning teaching and assessment and simulation
Nursing students, with paramedics, police child and youth services, during course	Riesen et al (2012) Canada	Blended learning approach including virtual face to face, traditional face to face and online approaches	Virtual learning environment and online/e-learning teaching and assessment
Nursing students, during course	Rigby et al (2012), UK	Blended enquiry-based learning model for mental health nursing students	Virtual learning environment
Nursing students, during course	Rush et al (2011), UK	Videoconferencing between classroom and clinical area (diabetic clinic)	Online/e-learning teaching and assessment
Nursing students, during course	Smith et al (2012), Australia	Online role-play to actively engage students in authentic learning experiences and help develop their clinical reasoning skills; role-based simulation.	Online/e-learning teaching and assessment
Nursing students, during course – 1 st year	Smith et al (2011), Australia	Online scenario based interactive learning	Online/e-learning teaching and assessment
Nursing students, during course	Smith and Barry (2013), USA	Simulation activity (elderly diabetic care)	Simulation
Nursing students, during course	Vogt et al (2010), USA	Podcasting	Digital teaching aids

Appendix 5: Allied health professions: technological innovations

Professional group(s) and student journey stage	Author, date of publication and country	Innovative intervention	Technological innovation type
Human services and counselling students, during course	Adcock et al (2010) U.S.A	Web-based interview skills	Simulation
Midwifery, paramedic and physiotherapy students, during course	Callaghan et al (2011), U.K	Video resources to support learning of research	Online/e-learning teaching and assessment
Occupational therapy students, 1st year, during course	Casteleijn and Steyn (2010), South Africa	Learning management system, click-UP using Blackboard as the operating system.	Virtual learning environment
Health professionals, during course	Cook et al (2013), USA	Systematic review of simulation based education	Simulation
Nursing and health sciences students, during course	Eales-Reynolds et al (2012), UK and Australia	Using an innovative web 2.0 tool for the development of critical thinking skills	Online/e-learning teaching and assessment
Health care workers, undergraduate and postgraduate	Ghosh et al (2013), Ireland	Novel artificial intelligence system (SureWash;GLANTA) ward-based automated hand hygiene training system	Online/e-learning teaching and assessment
Social work, physiotherapy, occupational	Gordon (2010), U.K	Planning e-learning materials for inter-professional education to promote collaboration and service user presence in the classroom'	Online/e-learning teaching and assessment

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therapy, nursing and sports/exercise students, during course			
Health care professionals, postgraduate	Harder (2010), Canada	Simulation in teaching and learning	Simulation
Health care professionals, postgraduate	Harrison et al (2012), U.K, Hong Kong	An asynchronous online case discussion assessment, to replace a traditional case study assessment, in medical ultrasound Programmes.	Online/e-learning teaching and assessment
Health Professions students, during course	Lachmann et al (2012), Sweden	'Contextual Activity Sampling System'; collection of data on experiences an on-going basis whilst in practice placement	Digital teaching aids
Physiotherapists, occupational postgraduate therapists, nurses, and exercise physiologists	Maloney et al (2011), Australia	Web-based approaches for training clinicians in prescribing exercise to prevent falls.	Online/e-learning teaching and assessment
Physiotherapy students - 3 rd year, during course	Maloney et al (2013), U.S.A	Pre-recorded video tutorial or student self-video for practical skills	Online/e-learning teaching and assessment
Physiotherapy students, during course	Maloney et al (2012), Canada	Experiential practice and reflection on performance through student self-video, and exposure to peer benchmarks, to increase competency	Online/e-learning teaching and assessment
Physiotherapy students, during course	Maloney et al (2013), Australia	online learning repository: 'Physeek'	Online/e-learning teaching and assessment
Health care professions, postgraduate	Rosen et al (2012), U.S.A	Simulation-based training, systematic review	Simulation
Occupational	Solomon et al (2010),	Asynchronous e-learning online inter-professional modules	Online/e-learning

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therapy, medicine, physiotherapy, social work, speech language, health promotion, dietetics, pharmacy students, during course	Canada		teaching and assessment
Dental hygienists, during course	Springfield et al (2012), USA	Online degree-granting dental hygiene program	Online/e-learning teaching and assessment
Health care professionals, undergraduate and postgraduate	van Soeren et al (2011), Canada	Simulated inter-professional education using video-recorded role-plays and debrief sessions	Online/e-learning teaching and assessment
Medical students, final year, during course	Zollner et al (2013), Germany	Student centred e-learning project in clinical pharmacology	Online/e-learning teaching and assessment

Appendix 6: Medical: non-technological innovations

Professional group(s) and student journey	Author, date of publication and country	Innovative Intervention	Innovation type
Medical students, during course – 1 st and 2 nd years	Abdelkhalek et al (2010), UAE	Team-based learning as preparation for problem based learning	Team-based learning
Medical students, during course, 3 rd year	Aronson et al (2011), USA	Development of a literature-based reflective writing guide	Reflection
Medical, dentistry and pharmacy students, during course	Attar et al (2011), Iran	Development of a logbook for recording and analysing ideas in practice	Reflection
Medical students, during course	Besdine et al (2011), USA	Varied curriculum changes based on active learning strategies	Active learning
Medical students, during course – years 3-5	Chinnah et al (2011), USA	Peer physical examination and palpation for teaching human anatomy	Active learning
Medical students, during course – 1 st year	Davidson (2011), Canada	Blend of curriculum changes including team-based learning and online learning modules	Team-based learning
Medical students, during course – Final year	de Feijter et al (2012), The Netherlands.	A patient safety course based on reflective learning and personal experiences	Reflection
General practitioner trainees	Dory et al (2010), Belgium	Development of an authentic assessment instrument for use in summative assessment. An assignment was designed based on the ask, acquire, appraise and apply steps of EBP	Assessment instrument
Medical students, during course	de la Croix et al (2011), Netherlands	Introducing Performing Arts in medical education:	Arts-based learning
Medical and Nursing	Fitch et al (2011),	Survivors (patients) teaching students: increasing awareness about	Service user and

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students, during course	Canada	ovarian cancer	carer involvement in teaching
Medical students, during course	Hettema et al (2012), USA	Development of a Performance Feedback Tool to Build Learner Confidence	Assessment and feedback
Medical students, during course	Hudson et al (2012), Australia	A Clinical Log was introduced as part of a medical student learning portfolio, aiming to develop a habit of critical reflection and an innovative Clinical Log station was introduced in the OSCE as an incentive	Reflection
Medical students, during course	(Inuwa et al, 2012), Oman	Implementing a modified team-based learning strategy	Team-based learning
Medical students, during course – 1 st year	Jarris et al (2012), USA	Students enrolled in Social and Cultural Issues in Health Care completed pre-tests and post-tests that assessed their awareness and knowledge of culturally responsive care and health disparities.	Assessment
Medical students, during course	Kam et al (2013), Australia	A structured revision programme including peer-assisted learning	Peer assisted learning
Medical students, during course – 2 nd – 4 th Years	Kassab and Hussain (2010), Kingdom of Bahrain	Concept maps as a method of assessment in problem based learning	Assessment
Medical students, during course – 2 nd year	Kushner et al (2011), USA	Teaching the principles and practice of health behaviour change and self-care using a behaviour change plan	Experiential learning/active learning
Medical students, during course	Koponen et al (2011), Finland	Teaching interpersonal communication competence through: theatre in education; simulated patient interview with amateur actors; and role-play with peers.	Experiential learning with actors and simulation
Medical students, during course	Lim et al (2011), New Zealand	How to act-in-role – to teach empathetic skills of communication	Experiential/active learning
Medical students, during course and postgraduate	Litvin et al (2012), U.S.A	Development and use of clinical decision-support (CDS) tools to facilitate geriatric education.	Clinical support
Medical students, during course – 4 th year	Mueller et al (2010), U.S.A	A novel advance directives course provides a transformative learning experience for medical students	Transformative learning

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Medical students, during course	Narayanan et al (2011), India	Student-Involved Demonstration Approach to Teach the Physiology of Vestibular Apparatus	Experiential/ active-learning
Medical students, during course – 1 st and 2 nd year	Noor et al (2011), U.K	Introduction of Learning Opportunities in the Clinical Setting (LOCS), allowing students to choose half day sessions from a list to provide experiential clinical learning	Experiential clinical learning
Medical students, during course	Pham et al (2010), Australia	Introducing clinical paediatrics - a novel hospital visitation programme involving Kindergarten children	Experiential/ active-learning
Medical students, during course	Reilly et al (2012), U.S.A	Using Theatre to Increase Empathy	Experiential/ active-learning
Medical students, during course	Roberts et al (2011), U.S.A	Teaching medical students about obesity through longitudinal relationships with bariatric surgery patients	Experiential/ active-learning
Medical students, during course – 1 st year residents	Ross et al (2012), Canada	Development of a competency-based achievement system - assessment	Assessment
Medical students, during course – 1 st and 2 nd Years	Shield et al (2011), USA	Teaching communication and compassionate care skills through use of cases and videos depicting successful and ineffective interactions, role play and skills practice, guest patient presentations, and multi-disciplinary panels.	Experiential/ active-learning
Medical students, during course – 2 nd year	Sutin et al (2011), USA	Introducing Actors to role player older adults	Experiential/ active-learning
Medical students, during course – 1 st and 2 nd year	Taylor et al (2013), USA	Peer mentorship in teaching clinical skills	Peer mentorship
Medical students, during course	Thomson et al (2011), Australia	Blended learning: an initial e-learning module and a subsequent practical component.	Blended learning
Medical students, during course	Vivekananda-Schmidt et al (2011), UK	Learning reflective skills – an Evaluation	Reflection

Appendix 7: Nursing: non-technological innovations

Professional group(s) and student journey stage	Author, date of publication and country	Innovative intervention	Technological innovation type
Nursing students, during course	Autry and Walker (2011), U.S.A	Artistic representation to promote students' creativity and enhance their ability to self-reflect	New teaching methods
Nursing students, during course	Baldacchino (2010), Malta	Clinical placement promoted the delivery of spiritual care to clients in Lourdes	Practice placement
Nursing students, during course	Blum et al (2010), U.S.A	High-fidelity patient simulation to increase student self-confidence and clinical competence	New teaching methods
Nursing students, during course	Burns et al (2010), U.K and U.S.A	High-fidelity simulation	New teaching methods
Nursing students, during course	Buykx et al (2011), Australia and U.K	FIRST ² ACT: Educating nurses to identify patient deterioration — A theory-based model for best practice simulation education evidence-based elements of assessment, simulation, self-review and expert feedback	Support and training in practice
Nursing students, during course	Byrne et al (2013), Australia	Teaching recovery in mental health nursing' by a person with a lived experience of significant mental health challenges	New teaching methods
Nursing students, during course	Chan (2012), Hong Kong	Role-playing in problem based learning	New teaching methods
Nursing students, during course	Chojceki et al (2010), Canada	Peer learning approach	New teaching methods
Nursing students, during course	Christiansen and Bell (2010), U.K	Peer learning partnerships	Support and training in practice
Nurses and midwifery students, postgraduate	Crozier et al (2012), UK	Action research methodology was used to develop partnership working between the hospital and university	Support and training in practice

Nursing students, during course	Duff et al (2012), Australia	Integrated clinical learning model to inform on-going education for surgical nurse via Respiratory Skills Update (ReSKU) education program to improve surgical nurses' respiratory assessment.	Support and training in practice
Nursing students, during course and postgraduate	Evans et al (2010), U.K	Putting Knowledge to Work Framework; the 're-contextualisation' approach for nurse education (Christiansen and Bell, 2010)	New teaching methods in theory and practice setting
Nursing students, during course	Gerdeman et al (2013), U.S.A	Concept mapping to build clinical judgment skills	Teaching methods
Nursing students, during course	Haddad (2010), U.S.A	Playing a standardized patient in an ethics course through clinical simulation and self-reflection	Teaching methods
Nursing students, during course	Karns (2010), U.S.A	Planning care using a concept map care plan	Teaching methods in clinical practice
Nurses, postgraduate	Kelly and Fry (2013), Australia	Innovative simulation education strategy to develop authentic scenarios	Teaching methods
Nurses, postgraduate	Lazic et al (2011), Serbia	Nurse education programme in paediatric oncology using appreciative inquiry	Teaching methods in clinical practice
Nursing students, during course	Lechasseur et al (2011), Canada	Knowledge mobilized by a critical thinking process deployed by nursing students in practical care situations	Teaching methods in clinical practice
Nursing students, during course	Lillyman et al (2011), UK	Using a storyboarding technique in the classroom to address end of life experiences in practice and deeper reflection	Teaching methods
Nursing students, during course	Lindsey and Jenkins (2013), U.S.A	Novel educational intervention on student nurses' clinical judgment regarding the management of patients experiencing rapid clinical deterioration.	Teaching methods
Nursing students, during course	McCurry and Martins (2010), U.S.A	Teaching Undergraduate Nursing Research via active learning assignments, reading quizzes, clinical nurse researcher presentations, and collaboration with clinical course assignments	Teaching methods
Nurses and midwives, postgraduate	McDonald et al (2012) Australia	A work-based educational intervention to support the development of personal resilience in nurses and midwives through a participatory learning group	Teaching methods in clinical practice
Nursing students, during course	McLafferty et al (2010), Scotland	Gaming workshops to prepare nursing students for caring for older people in clinical practice	Teaching methods
Nurses, postgraduate	Meng and Sullivan (2011), U.S.A	Interactive theater: an innovative conflict resolution teaching methodology	Teaching methods

Nursing students, during course	Pellico et al (2012), U.S.A	Adult-oriented educational method for learning, developing, and improving physical assessment skills for accelerated master's-entry students. The project used art works in a museum and visual training as a means to develop observational and diagnostic reasoning skills	Teaching methods
Nursing students, during course	Rees (2013), England	Reflective practices in enabling final year nursing students to respond to the distressing emotional challenges of nursing	Teaching methods
Pre-commencement and enrolment	Rhodes-Martin and Munro (2010), UK	A course entitled 'Portfolio of Evidence for Entry to Level 1 Study' was developed to enable potential nursing students without standard entry qualifications to demonstrate their skills in numeracy and literacy	Widening participation
Nursing students, during course	Rieger and Chernomas (2013), Canada	Arts-based learning	Teaching methods
Nursing students, during course	Savage et al (2011), Sweden	Working as teachers, students created continuing nursing education (CNE) courses using the Adaptive Reflection process.	Teaching methods
Nursing students, during course	Sims-Giddens et al (2010), U.S.A	Student-to-student peer mentoring teaching strategy was used to deliver health care to at-risk populations in a community-based setting.	Teaching methods in clinical practice
Nursing students, during course	Sisk (2011), U.S.A	Team-based Learning, systematic review	Teaching methods
Nursing students, during course	Terry (2012), UK	Service user involvement in classroom settings, literature review	Teaching methods
Nurses, postgraduate	Timmermans et al (2012), The Netherlands and Belgium	Team learning and innovation in nursing, literature review	Teaching methods in clinical practice
Nurses, postgraduate	Vittrup and Davey (2010), Australia	Structured group problem based learning activity	Teaching methods
Nursing students, during course	Webster (2010), UK	Promoting empathy through a creative reflective teaching strategy	Teaching methods
Nursing students, during course	Zavertnik et al (2010), U.S.A	Learner centred simulation intervention designed to improve the communication skills of nursing students.	Teaching methods

Appendix 8: Allied Health Professions: non-technological Innovations

Professional group(s) and student journey	Author, date of publication and country	Innovative Intervention	Innovation type
Allied health professions students, during course	Abu-Rish et al (2012), USA	Current trends in inter-professional education of health sciences students	Literature review
Occupational therapy and physiotherapy students, during course	Adam et al (2013), Australia	Development of an industry consultancy service to provide clinical learning for students who delivered injury prevention services with supervision from experienced educators.	Practice-based Learning
Health-care workers	Fitzpatrick et al (2011), USA	A novel educational programme to improve knowledge regarding health care-associated infection and hand hygiene	Delivery model
Nursing and physiotherapy students, during course	Fogstad and Christiansen (2011), Norway	Peer supported learning: partnering second-year physiotherapy students as tutors with first-year nursing students as tutees	Peer learning
Medical and physiotherapy students, during course	Hayward and Blackmer (2010), USA	Delivery model designed to teach and assess core values development - the model combines standardized patients (SP), online communities of practice, and reflection.	Delivery model
Allied health professions students, during course	Johnston et al (2012), USA.	Instrument to quantify basic communication skills	Assessment model
Midwives, 3 rd year and paramedics, 2 nd year, during course	McLelland and French (2011), Australia	Introduction of peer assisted learning techniques; teaching skills	Delivery model
Dentistry students	Obrez et al (2011),	Independent class preparation with active small-group discussion and	Delivery model

during course	USA	patient scenario-based wax-up exercises to replace missing tooth structure on manikin teeth.	
Physical therapist students, during course	Rapport et al (2010), USA	Students paired with community volunteers who have a self-identified physical disability. Each student follows his or her volunteer throughout the 3-year curriculum and learns about life with a disability directly from the volunteer's and family's perspectives and experiences.	Service user and carer involvement
Dental students, during course	Rogers et al (2011), U.S.A	Training dentists to be able to give people with HIV/AIDS compassionate and comprehensive care through self-evaluation of knowledge, attitudes, and confidence in the efficacy of precautions and post-exposure prophylaxis following blood borne exposures.	Delivery model
Occupational therapy students, during course	Rubin et al (2011), UK	Appreciative inquiry in occupational therapy education	Delivery model
Inter-professional health care students, during course	Shiyanbola et al (2012), USA	Student-led inter-professional innovative health promotion model with diabetic patients	Practice-based learning
Nursing and podiatry students, during course	Warner et al (2010), Australia	Students invited to attend the established University clinic and undertake assessment tasks relevant to their profession as well as learn and practice clinical skills outside their usual professional practice.	Practice-based learning

Appendix 9: Grey literature

Professional group(s) and student journey	Author, date of publication and country	Innovative Intervention	Technological innovation type
Occupational psychology practitioners in employment	(Nie et al., 2011), UK	Podcasting in the curriculum	Digital teaching aids
Nursing, operating department technicians	(Fell and Birmingham City University, 2013), UK	Developing essential knowledge and skills via mobile technology	Digital teaching aids
Pharmacy students during course	(Vosper, 2012), UK	Simulation as an alternative form of clinical placement	New teaching and assessment methods
Nursing students during course	Rigby (2010) UK	Enquiry based learning approach	New teaching and assessment methods

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