Title: An evaluation of approaches used to teach quality improvement to pre-registration healthcare professionals: an integrative review.

Abstract

Background: Improving the quality of healthcare remains central to UK and international policy, practice and research. In 2003, The Institute of Medicine's '*Health Professions Education: A Bridge to Quality',* advocated quality improvement as a core competency for all healthcare professionals. As a result, developing capacity and capability of those applying improvement methodologies in the pre-registration population has risen, yet, little is known about the teaching approaches employed for this purpose. **Objectives**: To describe and analyse educational approaches used to teach quality improvement to pre-registration healthcare professionals and identify enabling and impeding factors. **Design:** Integrative Review. **Data Sources:** CINAHL, PsychINFO, MEDLINE, ERIC, ASSIA, SCOPUS and Google Scholar were accessed for papers published between 2000-2016. **Review Methods**: Publications where quality improvement education was delivered to pre-registration healthcare professionals were eligible. One author independently screened papers, extracted data using a modified version of the Reporting of Primary Studies in Education Guideline and evaluated methodological quality using the Weight of Evidence Framework. The Kirkpatrick Education Evaluation Model was used to explore the impact of teaching approaches. Enabling and impeding factors were thematically analysed. A narrative synthesis of findings is presented. **Results**: Ten papers were included, representing nursing, pharmacy and medicine from UK, Norway and USA. Studies comprised four quantitative, four mixed method, one qualitative and one cluster randomised trial, all allocated medium Weight of Evidence. Teaching approaches included experiential learning cited in all studies, didactics in seven, group work in four, seminars in three, self-directed learning in three and simulation in one. Most studies measured Level 1 of the Kirkpatrick Model (reaction), all but one measured Level 2 (skills, knowledge or attitudes), none measured Level 3 (behaviour) and one measured Level 4 (patient outcomes). Enabling and impeding themes included: Teaching Approaches, Clinical/Faculty support, Information Provision, Curriculum Balance and Data. **Conclusions**: Evaluating quality improvement education is complex. Experiential learning

combined with didactics is the favoured approach; however, attributing causality to educational intervention proves difficult in light of poor methodological rigour, lack of validated tools and complex clinical settings. Clarity regarding which quality improvement competencies are priority for this population would be useful to streamline future educational development and evaluation. Stronger collaboration between educators and clinicians is recommended to explore the multiple components and contextual factors associated with quality improvement education in practice. Ethnographic enquiry may be a logical next step to advance knowledge within the field.

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Keywords: Evaluation, Healthcare Education, Pre-registration, Quality Improvement, Pedagogy, Ethnography

1. Background

Quality improvement remains at the forefront of political and educational agendas internationally, continuing to be a key priority within healthcare (Scottish Government, 2010; Health Foundation, 2012a; Institute of Medicine, 2001; Academy of Medical Royal Colleges, 2016). In 2003, *Health Professions Education: A Bridge to Quality'* (Institute of Medicine, 2003) recommended quality improvement as a core competency for US healthcare curricula. The UK Nursing and Midwifery Council's education standards now insist that in order to become a registered practitioner, nurses must also demonstrate competence by '*acting as change agents and provide leadership through quality improvement and service development to enhance people's wellbeing and experiences of healthcare'* (NMC, 2010). Until now, little research about the impact of approaches used to teaching quality improvement to this population exist (Health Foundation, 2012a; Jones et al., 2013; Tella et al., 2014; Carson-Stevens et al., 2014).

Previous reviews aiming to educate healthcare professionals in quality improvement focus on the medical profession, middle management or post-registration populations (Health Foundation, 2012a; Abbas et al., 2011; Nadeem et al., 2013; Schotuen et al., 2008; Benn et al., 2009; Ahmed et al., 2013; Boonyasai et al., 2007; Okuyama et al., 2011; Gordon et al., 2012; Wong et al., 2010 and Jones et al., 2014). These reviews identify improvements in knowledge, skills or attitudes (Boonyasai et al., 2007; Wong et al., 2010 and Jones et al., 2014) and patient or organisational outcomes (Jones et al., 2014); yet, there is inadequate evidence of changed behaviour. Moreover, studies are criticised for poor design, lack of intervention description, question validity of assessment tools and demonstrate little use of longitudinal methods and sound theoretical underpinnings (Boonyasai et al., 2007; Okuyama et al., 2011; Gordon et al., 2012; Jones et al., 2014). Our review aims to develop the evidence related to the pre-registration healthcare population and determine the impact of various quality improvement

pedagogical approaches, and to extend the learning beyond nursing literature to explore differences and similarities between the disciplines.

Prior to undertaking the review, best practice was followed and a study protocol was developed (Moher et al.2015). Protocols eliminate, or at least reduce, researcher bias whereby *'reviewers selectively choose which information to include in a report based on the direction and significance of the findings'*. Our protocol (Armstrong et al., 2015) aimed to counteract reporting bias (Shamseer et al., 2015) by explicating our hypothesis, methods and rationale in advance.

We combined two theories which set the expectation of how an intervention was likely to enable change (MRC, 2008); Experiential Learning (Kolb, 1984) and Bandura's Social Learning Theory (Bandura, 1977). The first reflected similarities between Kolb's Experiential Learning Model and The Model for Improvement (frequently used in healthcare), in that their cyclical process overlapped. In the former, cycles comprise 1) active involvement, 2) reflection, 3) analytical thinking and 4) decision-making, and in the latter of Plan-Do-Study-Act cycles. 'Plan' requires individuals to know the who? when? where? and what data to collect which indicates the need for active involvement. 'Do' and 'study' require analysis of data and reflection on the learning from each cycle, leaving 'Act' to determine (from that data) which modifications to make. This parallel indicated that experiential learning could have a major impact to improve skills, knowledge and attitudes. Given our tacit knowledge of complexities arising within the healthcare environment and the necessity to inspire behaviour change, Bandura's Social Learning Theory (1977) enabled further understanding of how quality improvement education may (or may not) work. The theory suggests that learning is socially constructed through *'modelling';* which is to observe and mimic other's behaviour. We hypothesised that experiential learning would impact positively on students' skill, knowledge and attitudes, whereas, the observing behaviours in practice would influence behaviour change.

2. Aims and Objectives

To review, describe and analyse the educational approaches used to teach quality improvement to pre-registration healthcare professionals. The objectives were to:

i. Identify and describe teaching approaches used in quality improvement education for pre-registration healthcare professionals.
ii. Determine the impacts of the teaching approaches.
iii. Establish enabling or impeding factors in the delivery of quality improvement education to pre-registration healthcare professionals.

3. Design

Subsequent to our review protocol we adopted Whittmore and Knafl's (2005) integrative review framework. This method allowed for diverse study designs to be synthesised and is favoured where there is limited available research. Rigour was maintained using the Guidance on the Conduct of Narrative Synthesis in Systematic Reviews (Centre for Reviews and Dissemination, 2009) and transparency enhanced using The PRISMA Framework (Moher et al., 2009).

4. Methods

4.1 Literature search strategy

One of the review team developed and conducted the search (LA) in accordance with an expert subject librarian (VW). Detailed search terms were applied in CINAHL, PsychINFO, MEDLINE, ERIC, ASSIA, SCOPUS and Google Scholar. A primary search was developed in MEDLINE using MeSH terms (EPPI, 2005) an example of which is detailed in Table 1. Searches were translated for each database and reference lists of eligible articles scanned for additional sources. Searches were conducted in June 2014 and updated in June 2016. Data were uploaded to Refworks (Version 2) and duplicates removed.

4.2 Eligibility criteria

Peer reviewed primary studies that reported pre-registration healthcare professionals were eligible if they had an English language abstract and an evaluative outcome. The review focussed on teaching quality improvement methodology. We therefore included studies if one of the most common quality improvement models in healthcare was reported: (Total Quality Management, Continuous Quality Improvement, Business Process Reengineering, Model for Improvement/Plan-Do-Study-Act, Lean Thinking or Six Sigma) (Powell et al., 2009). The protocol was amended to remove geographical limitations, in order to gain insight from international best practice. Given the introduction of quality improvement to healthcare in 2001 (Institute of Medicine, 2001), studies published from 2000-2016 were included.

4.3 Screening and selection

Eligible articles were screened independently by a member of the review team (LA) over two stages. Firstly, pre-determined criteria were applied to titles and abstracts whereby those found to be irrelevant were excluded. To enhance transparency of the selection process and retain potential studies for contextual understanding and/or discussion, ineligible articles were excluded, grouped and allocated codes (Gough et al., 2013). Secondly, where articles were eligible or where uncertainty arose, full documents were retrieved and read in full before making a final decision. A second member of the review team, with in-depth subject knowledge (AS), cross checked a random sample of approximately 20% of the articles to determine reliability in the selection process and full agreement was reached.

4.4 Data extraction and analysis

A standardised data extraction form based upon the Reporting of Primary Studies in Education (EPPI, 2005) guidelines was adapted to take account of outcomes relating to the four Levels of the Kirkpatrick Educational Evaluation Model (Kirkpatrick, 2009). The four tier model is used to evaluate training programmes, one of which is quality improvement education. At Level 1 (student reaction) interests were to obtain students' perceptions about their preferences and

usefulness of approaches. At Level 2 (skills, knowledge and attitude) we examined the learning outcomes being measured and whether a relationship, if at all, existed between the teaching approaches. At Level 3 (behaviour) we sought to identify if students transferred new knowledge or skills to clinical practice post intervention and at Level 4 (patient/organisational outcomes), in noting improvements to patient care or processes.

Enabling and impeding factors were extracted where available, or where the review team identified them as potential factors. Vote counting was applied across studies; where factors were identified more than once a theme was formed. Data were extracted by one member of the review team (LA). Bias was minimised and validity enhanced by a second member (AS) who extracted data from a random sample of 20%. Reviewers met to compare and check the detail and accuracy of data extraction and compare themes emerging from enabling or impeding factors.

4.5 Evaluation of methodological quality and relevance of studies

Inconsistent critical appraisal for quality improvement education studies is common (Health Foundation, 2012a; Abbas et al., 2011; Nadeem et al., 2013; Schotuen et al., 2008; Benn et al., 2009; Ahmed et al., 2013; Boonyasai et al., 2007; Okuyama et al., 2011; Gordon et al., 2012; Jones et al., 2014) and upholding rigour and transparency is paramount (Reed et al., 2005). The Weight of Evidence Framework (Gough, 2007) was adopted as it aligned with different populations and favoured the *relevance* of research studies in terms of answering the review's objectives. Overall Weight of Evidence was scored using a pre-determined formula e.g. a study had to achieve a *high* score in no less than two sub-categories within Weight of Evidence A to achieve an overall Weight of Evidence of *high*. In contrast, studies had to be allocated a *low* score in at least two sub-categories to be excluded (Gough et al., 2013) (see additional file 1). Two members of the review team (LA, AS) assessed eligible articles and compared 10% in which full agreement was reached. A third member of the review team (FH) assessed one paper independently, as it had been co-authored by two members of the review team (LA/AS).

Table 1 MEDLINE (OVID) Search Strategy

1.	exp quality Improvement*/
2.	(science of improvement or improvement science or continuous quality improvement or total quality management or quality standards or improvement models).tw.
3.	1 or 2
4.	exp education*/
5.	course$.tw.
6.	train$.tw.
7.	curricul$.tw.
8.	teach$.tw.
9	learn$.tw.
10.	4 or 5 or 6 or 7 or 8 or 9
11.	student.ab.
12	trainee.ab.
13.	learner.ab.
14.	(undergraduate).ab.
15.	11 or 12 or 13 or 14
16.	exp programme evaluation/
17.	evaluat$.ab.
18.	16 or 17
19.	3 and 10 and 15 and 18

5. Results

5.1 Literature Search

Results are illustrated in the PRISMA Flow Diagram (Figure 1). During screening, four discrepancies occurred between reviewers all of which were resolved by re-reading full text articles and further discussion. Ten studies were included in the final synthesis (Tables 2-4).

5.2 Characteristics of studies

As Table 2 illustrates, studies comprised four quantitative, four mixed method, one qualitative and one cluster randomised trial, all of which were allocated a medium Weight of Evidence (see additional file 1). There were five studies from the USA, two from Norway and three from the UK. Disciplines included medicine, pharmacy and nursing. Papers included students from first through to third year. Most studies described Plan-Do-Study-Act cycles (or Plan-Do-Check-Act), three mentioned Continuous Quality Improvement, one mentioned FOCUS (see footnote) and another mentioned audit combined with Model for Improvement. Table 3 illustrates that most studies measured Level 1 (reaction) of the Kirkpatrick Model, all but one measured Level 2 (skills, knowledge or attitudes), none measured Level 3 (behaviour) and one measured Level 4 (patient outcomes).

5.3 Overview of methodological quality and relevance

Of the quantitative studies, three adopted a quasi-experimental design (Kyrkjebo et al., 2001; Gould et al., 2002; Gonsenhauser et al., 2012) and one used post intervention evaluation (Christiansen et al., 2010). Of the mixed method studies, one adopted a quasi-experimental design (Levit et al., 2012) and three used post intervention evaluation (Baillie et al., 2014; Kyrkjebo, 2006; Skledar and McKaveney, 2009). The qualitative study was a post-intervention evaluation (James et al., 2016).

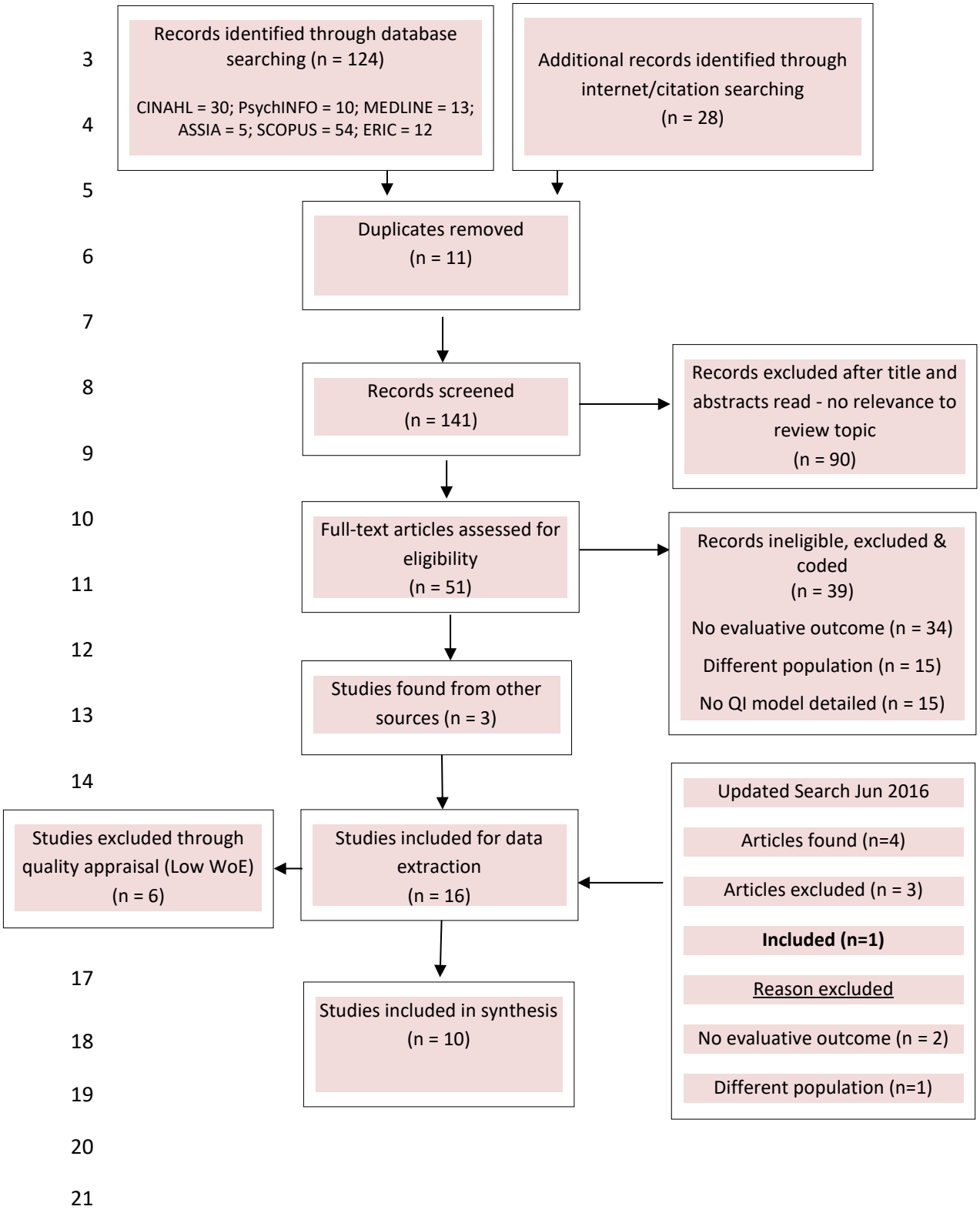
Quantitative Studies: The sample sizes of the quasi-experimental designs included 25 in the Gonsenhauser et al. (2012) study, 52 in the Kyrkjebo et al. (2001) study and 77 in the Gould et al.study (2002). No validated assessment tools were utilised pre or post intervention to

evaluate knowledge, attitudes or beliefs. Limitations included non-submission of pre intervention answers to determine post intervention improvement (Kyrkjebo et al., 2001); lack of reported data, uncertainty over participant's consent (Gould et al., 2002); and recruitment bias through an Institute of Healthcare Improvement Open School Chapter (Gonsenhauser et al., 2012). The sample size of 134 was greater in the post intervention evaluation. The utility of a stakeholder informed questionnaire to evaluate knowledge and attitudes strengthened findings, yet insufficient intervention description made it difficult for replication (Christiansen et al., 2010).

Mixed Method Studies: The mixed method quasi-experimental study (Levit et al., 2012) recruited eight participants and adopted the Quality Improvement Proposal Assessment Tool (QIPAT-7), validated to assess quality improvement skills pre and post intervention. No validated tools were used to evaluate knowledge or attitudes. Focus groups consisted only of one question and recruitment and analysis were not reported. Sample sizes were higher in post intervention studies. One study included a questionnaire to 89 participants and 25 semi-structured interviews (Baillie et al., 2014) to evaluate experience, attitudes and knowledge. The self-reported questionnaire was adapted from one used in a previous UK national initiative (Johnson et al., 2010) which authors claim underwent critical review for coherence. The intervention was not described sufficiently to allow for replication.

The second study (Skledar and McKaveney, 2009) recruited 76 participants to determine knowledge through grading of assignment presentations, however, authors of the paper also formed the marking panel. Voluntary formative evaluation was undertaken to assess satisfaction and attitudes of participants, yet how the analysis and interpretation were conducted is unclear. Lastly, one study (Kyrkjebo, 2006) utilised their own questionnaire with 44 participants alongside focus group interviews and assignment reports, to evaluate reaction, attitudes and knowledge. The number of questionnaires completed was not stated and data reported was primarily from focus groups and student assignments; the methods of which are vague.

Fig 1. Flow Chart presenting an overview of systematic search and review process



Qualitative study: The qualitative study (James et al., 2016) consisted of 18 semi-structured interviews post intervention to determine student experiences of completing quality improvement in clinical practice. Analysis of reflections from 50 students assignments were extracted using a Quality Improvement Principles (QIP) tool developed by the authors. Assignment reflections were analysed thematically in tandem with verbatim interview transcriptions. Only the interview data is reported.

Cluster Randomised Trial Study: The cluster randomised trial (Ogrinc et al., 2007) measured knowledge of 39 participants using a non-validated Quality Improvement Knowledge Application Tool (QIKAT) pre and post intervention and student performance measured during Observed Structured Clinical Examinations. The intended randomised cross-over trial with an early and late intervention group did not run due to time constraints. Student self-assessed proficiency and satisfaction were measured using Likert scales and/or free text evaluation. Satisfaction of educational facilitators was also obtained from focus groups, however, the methods or questions are not detailed.

Table 2 Summary of quality improvement education studies

Author	Discipline	Teaching Approach(es)	Outcome Measure(s)	Learners	Model
Baillie et al. (2014) (Mixed method)	Nursing (UK)	Didactic/experiential learning	Student experience & perceptions, academic staff experience	3rd year nursing students	PDSA
Christiansen et al. (2010) (Quantitative)	Nursing (UK)	Didactic/experiential learning/group work	Knowledge & attitude	3rd year nursing students	PDSA
James et al. (2016) (Qualitative)	Nursing (UK)	Didactic/experiential learning self-directed /workshops	Student experience	3rd year nursing students	PDSA/MFI
Kyrkjebo et al. (2001) (Quantitative)	Nursing (Norway)	Didactic/experiential learning/group work	Knowledge, understanding, perceptions & experience	2nd year nursing students	PDSA/CQI
Kyrkjebo (2006) (Mixed method)	Nursing (Norway)	Seminar/didactic experiential learning	Learning and implementation	1st year nursing students	PDSA
Gonsenhauser et al. (2012) (Quantitative)	Medicine (USA)	E-learning/simulation/self-directed/experiential learning	Knowledge & perspectives	1st & 2nd year medical students	Audit/MFI
Gould et al. (2002) (Quantitative)	Medicine (USA)	Didactic/seminar experiential learning	Knowledge, attitudes, beliefs & quality indicators	2nd year medical students	CQI
Levit et. al (2012) (Mixed method)	Medicine (USA)	Experiential learning self-directed	Satisfaction, knowledge, skills attitudes	3rd year medical students	CQI/PDSA
Ogrinc et al. (2007) (Cluster Randomised Trial)	Medicine (USA)	Group sessions/seminar experiential learning	Satisfaction/skills knowledge/impact	1st year medical students	MFI/ PDSA
Skledar & Mckaveney (2009) (Mixed Method)	Pharmacy (USA)	Didactic/group work experiential learning	Satisfaction learning & attitudes	3rd year pharmacy students	CQI/FOCUS-PDCA[1]

[1] FOCUS: find a process; organise an effort to work on improvement; clarify knowledge of process; understand process variation/capability; select strategy for continued improvement. PDCA: Plan; Do; Check; Act. MFI: Model for Improvement

Table 3 Data Extraction for Quality Improvement Education Studies

General Information	Introduction	Methodology	Intervention/Teaching Approach	Kirkpatrick Level
Ballie et al. (2014) Implementing service improvement projects within pre-registration nursing education: A multi-method case study evaluation	To evaluate the implementation of service improvement projects with a pre-registration nursing curriculum.	Multi-method case-study Questionnaire/focus groups with nursing students and academics/observation of Action Learning Sets	Didactic/experiential learning Introductory sessions on being patient focussed, process mapping and PDSA were given to nursing students. Degree students carried out service improvement projects over 9 weeks. Action Learning Sets were held twice for support throughout which were held by mentors who were registered nurses. Link tutors were available to help prepare the practice areas.	Experience (1) Attitudes (2) Perception
Christiansen et al. (2010) Creating an improvement culture for enhanced patient safety: service improvement learning in pre-registration education	To evaluate student Nurse's experience of service improvement learning in the university and practice setting.	Post Cross-sectional survey 14 item questionnaire open/closed questions likert scale (134 students completed)	Didactic/experiential learning/group work Introductory sessions on inter-professional learning and working, leadership, management of change, clinical governance and patient safety. Attendance at core learning day to hear experiences of service users and clinical experts Introduced to public/patient participation personal and organisational development, systems thinking and initiating/sustaining change Students then undertook work-based QI projects and were supported by mentors and Action Learning Sets. Projects presented and graded.	Knowledge (2) Attitudes
James et al. (2016) Time, fear and transformation: Student nurse's experience of *doing* a practicum (quality improvement project) in practice	To explore student nurse's experiences to provide evidence to inform the future design and delivery of a practicum within the undergraduate curricula.	Telephone and face to face interviews (n=18) Thematic analysis of student practicum assignments (n=50)	Didactic/experiential learning self-directed e-learning modules QI curriculum spanning 3 years. IHI e-learning modules each semester (9 in total). Supplementary didactic lectures, workshops, podcasts. Intro to QI, examples of QI initiatives, tools for QI, decision-making, intro to practicum, resilience. Students assessed on QI periodically in MCQ exams. 11 week QI project undertaken in 3rd year within clinical practice where students 'test' small changes using PDSA/MFI and complete compulsory assessed assignment.	Experience (1)

General Information	Introduction	Methodology	Intervention/Teaching Approach	Kirkpatrick Level	
Kyrkjebo et al. (2001) Introducing quality improvement to pre-qualification nursing students: evaluation of an experiential programme	To evaluate a programme introducing QI in nursing education.	Pre/post questionnaire likert scale/student reports 52 students (38 out of 52 completed)	Didactic/experiential learning/group work 1 hour classroom based introduction of tasks to be undertaken in clinical practice which excluded any QI theory. 10 wks in practice on surgical/medical wards. Students chose a patient to follow; recorded processes of care from patient perspective On return to theory students received 2 days QI learning and worked in groups to produce flow charts, cause/effect diagrams and define structure, process and results criteria relating to placement. A final report was submitted.	Reaction Knowledge Understanding Perceptions	(1) (2)
Kyrkjebo (2006) Teaching Quality Improvement in the Classroom and Clinic: Getting it wrong and Getting it Right	To describe a CQI personal improvement project and ascertain students experience of a CQI programme	Open ended questionnaire/focus group interview 44 students 39 female/5 male (All completed questionnaire)	Seminar/didactic/experiential learning Intervention over 3 semesters. 1st students are introduced to improvement methods and tools and work on a project using PDSA & process mapping to make a personal improvement and present projects to the after 8 wks. (Further details of intervention detailed within Kyrkjebo & Hanestand, 2003). In semester 2, students in care homes follow a patients' journey to get perspective of their experience and map process. Data collected and improvements suggested by students. Projects are presented to the class. In semester 3, students observe 1 patient in medical/surgical wards and review process and patients perspective. Using flowcharts and cause/effect diagrams they identify cause of problems, create goals with structure, process and result criteria and produce improvement plan within documented report.	Reaction Experience Knowledge Attitudes	(1) (2)

General Information	Introduction	Methodology	Intervention/Teaching Approach	Kirkpatrick Level	
Gonsenhauser et al. (2012) Development and assessment of quality improvement education for medical students at the Ohio State University Medical Centre	To evaluate a student driven educational QI programme integrated into the medical curriculum.	pre/post assessment likert-scale 60 student's (25 out of 60 completed)	E-learning/simulation/experiential learning 2 hrs self-directed online IHI e-learning modules in QI/patient safety leadership/teamwork and Person-Centred Care 2.5hrs orientation of operating theatre and role play using surgical safety checklist Observation of 3 operating room procedures with audit conducted	Knowledge Perspectives	(2)
Gould et al. (2002) Improving patient care outcomes by teaching quality improvement to medical students in community-based practices	To examine impact of a CQI curriculum on educational outcomes of students and the impact on quality indicators in practice.	pre/post open-ended questionnaire likert-scale (53 out 77 completed)	Didactic/seminar experiential learning Curriculum included clinical outcomes protocol development, chart abstraction & clinical process change through CQI. Students undertook a 2.5 hour chart abstraction seminar that provided CQI theory and differences and similarities between CQI and clinical outcomes In groups of 2-4 students at community based primary care practices collected baseline data, implemented a results specific intervention and re-assessed 6 months within later a diabetes clinic.	Reaction Knowledge Attitudes Quality Indicators	(1) (2) (4)
Levit et al. (2012) An innovative quality improvement curriculum for third-year medical students	To evaluate self-directed QI skills curriculum for medical students in a 1 year longitudinal third year clerkship.	QIPAT-7 pre/post survey Focus groups for facilitators (8 students 2 groups of 4)	Experiential learning/self-directed 1 year longitudinal experiential self-directed QI curriculum. Students had to analyse a process of care to identify a quality gap, provide measurement and recommend changes to close the gap. Students were supported with personal and email 'check ins' with programme director but no formal didactics. One group explored pain management in palliative care and the other explored preventable causes of delirium.	Satisfaction Knowledge Skills Attitudes	(1) (2)

General Information	Introduction	Methodology	Intervention/Teaching Approach	Kirkpatrick Level	
Ogrinc et al. (2007) Integrating practice-based learning and improvement into medical student learning: Evaluating complex curricular innovations	To evaluate effects and assess impact of a PBLI module for 1st year medical students.	Randomised two group trial. Standard module vs PBLI 83 students Pre/post likert scale Free text evaluation Focus Groups QIKAT tool	Groups/seminars/experiential learning During standard 20 minute seminars to review recording of patient information skills, intervention groups were given additional 10 minute overviews at 4 group sessions. Included were PDSA, data, system change and improvement. Students used this additional information to make a plan for improving their OSCE's in groups of 8-10.	Satisfaction Skills Knowledge	(1) (2)
Skledar and Mckaveney (2009) A method for teaching continuous quality improvement to student pharmacists through a practical application project	To describe/evaluate a mandatory continuous quality improvement module.	Assessment through project presentations and examination Voluntary formative evaluation of students attitudes (76% response rate from formative evaluation)	Didactic/group work/experiential learning 1st lecture – CQI theory, measures differences between QI and Research FOCUS/PDCA model (1hr). 2nd lecture included presentations from exemplars. Students in small groups then selected an area to improve providing 2 citations to justify or propose a solution. Some chose a topic outside of pharmacy. Students applied CQI methods to develop an action plan and present 15 slides to a panel of QI experts.	Satisfaction Knowledge Attitudes	(1) (2)

Table 4 Outcomes relating to Level of Kirkpatrick Educational Evaluation Model

Study	Teaching Method	Level	Results	Enabling/Impeding
Baillie et al. (2014) Medium WoE	Didactic/experiential learning	2	62% felt they knew a fair amount after training. Most students rated service improvement (SI) as very important or important generally, in relation to patient safety and the individuals healthcare experience. Less than 30% were *very* keen to get involved in SI, with 59% being keen. Only 5% felt *very* confident to get involved in SI, 51% were confident and 32% were unsure. Most students felt SI was *very* important or important to professional development and 60% felt it would help enhance career opportunities whereas 26% were unsure.	Teaching Approach Clinical Faculty Support Information Provision Curriculum Balance
Christiansen et al. (2010) Medium WoE	Didactic/experiential learning/group work	2	24% indicated they learned a lot, 68% learned a fair amount. Most indicated Service improvement (SI) was either *very* important or important. 85% rated it important for patient safety. 55% of mental health students were *very* keen to get involved in SI whereas less than a third felt this from the adult, learning disability and child branches. 53% of respondents were keen to get involved. 55% felt confident to get involved with SI work with 16% feeling very confident. 51% felt that it was *very* important for their professional development with 74% indicating it would enhance their employability. 85% felt that action learning sets enhanced their learning.	-
James et al. (2016) Medium WoE	Didactic/experiential learning/self-directed e-learning modules.	1	3 themes. <u>Time:</u> students highlighted time needed to prepare for the practicum, the need for a 'settling in period' on placement, challenges choosing topics in a given time and time to balance practice and theory. <u>Fear:</u> students feared measures, QI tools, QI terminology, making criticisms of practice and undertaking task as a student. <u>Transformation:</u> students helped through, process by a structured assignment, mock examples of QI projects and clinical support from staff.	Clinical/Faculty Support Information Provision

Study	Teaching Method	Level	Results	Enabling/Impeding
Kyrkjebo et al. (2001) Medium WoE	Didactic/experiential learning/group work	1 2	Students reported that it was *quite useful* to observe patient on one shift (mean 3.0). It was useful to a *large extent* working in groups (mean 3.7). Students found introductory course 'useful' 'to a large extent' (mean 4.0). 58% of students indicated they knew the meaning of QI concepts following clinical practice and before introductory session. 46% were unaware of current QI projects ongoing in the ward. 27% didn't know at all. Authors claim that knowledge of QI pre/post improved significantly. Pre - SD value 2.0 to post SD value 3.1. Most students considered topic *highly* relevant for later career (mean 4.2). Students learned something new 'too some extent' (mean 2.8). Students considered it 'important' for nurses to have knowledge about QI (mean 4.3).	Teaching Approaches Information Provision
Kyrkjebo (2006) Medium WoE	Seminar/experiential learning/didactic	1 2	All focus groups evaluated the lecture as informative. All focus groups reported that the CQI programme was not well integrated into the programme. No time was given to work on project which represented an extra workload and therefore did not get priority. Several students thought the personal improvement project was useful in learning about improvement methods and tools. Knowledge of patients' perspective increased students understanding of patient needs and provision of holistic care.	Teaching Approaches Clinical/Faculty Support Information Provision Curriculum Balance
Gonsenhauser et al. (2012) Medium WoE	E-learning/simulation experiential learning	2	Authors claim knowledge was significantly improved by 18%. 84% were more aware of IHI, improving from pre: 2.4 +/- 0.98 to post: 4.2+/- 0.37. Student understanding of what constitutes a QI initiative improved from pre: 3.75 +/- 0.84 to post: 4.27 +/- 0.48. Increased preparedness to observe operating room activity and report error was increased from pre: 3.50 +/- 0.76 to post: 4.10 +/- 0.30. Students were significantly more prepared to effectively contribute to QI initiatives from pre: 3.47 +/- 0.76 to post: 4.04 +/- 0.45. There was a significant increase that students believed physicians were responsible for identifying health care improvement from pre: 3.80 +/- to 4.30 +/- 0.48.	Teaching Approaches

Study	Teaching Method	Level	Results	Enabling/Impeding
Gould et al. (2002) Medium WoE	Didactic/seminar/ experiential learning	1	85% of students were neutral or did not find the learning chart abstract experience valuable. 83% had sufficient time to complete project 62% reported tasks & expectations were clearly defined.	Clinical/Faculty Support Curriculum Balance QI Data
		2	Knowledge improved significantly of the nature, Concepts and principles of CQI after training in some elements. 64% believed the audit was not intrusive to patient confidentiality. 68% agreed or strongly agreed on making decisions by relying on data. 45% agreed or strongly agreed that the audit was beneficial to office practice. Only 18% found it beneficial to the patient with 30% not finding it beneficial to the patient. 48% reported that the audit did not benefit quality of patient care. 46% agreed or *strongly* agreed that the experience improved documentation.	
		4	the rate of foot and eye exams for patients increased by 51% to 70%	
Levit et al. (2012) Medium WoE	Experiential learning	1	Students wanted the timeline shortened and more goals built in. They wanted more guidance and protected time to complete project.	Medium Teaching Approaches Clinical/Faculty Support
		2	No significant improvement in knowledge identified with mean score out of 11 questions – pre 5.9 vs post 6.6. Shortcomings in QI skills identified in final projects such as defining measures and applying timely goals for their interventions. Attitudes in students confidence increased significantly - pre 13.4 vs post 16.1. Perception of the value of QI projects increased significantly - pre 9.9 vs post 12.6 Students confidence in QI skills in confidence increased significantly - pre 13.4 vs post 16.1.	
Ogrinc et al. (2007) Medium WoE	Group sessions/seminar/ experiential learning	1	Students felt that the information could have been delivered in one session as opposed to 4 and they didn't feel it tied together very well. Students wanted more focus on practice.	Teaching Approaches Clinical/Faculty Support Information Provision Curriculum Balance
		2	31% of students felt satisfied with identifying best practice from the literature. 44% felt satisfied with developing an aim and using small cycle change. PBLI intervention group were better able to apply improvement knowledge on a skills based exam than the control group. No differences were found between scores in OSCE's.	

Study	Teaching Method	Level	Results	Enabling/Impeding
Skledar and Mckaveney (2009) Medium WoE	Didactic/group work/experiential learning	1	Students thought that timing of the practicum being before the holidays made it more difficult to form groups. Student wanted more time for questions and group work.	Teaching Approaches Clinical/Faculty Support Information Provision Curriculum Balance QI Data
		2	The mean score of practicum presentations for students learning was 93%. All students reported learning more through the practicum experience compared with the lecture alone. 80% of the students thought the lectures were informative or necessary. 85.7% students reported they thought the practicum added value to CQI learning. 91% of students recognised the potential of CQI for fostering improvement and 97% were able to provide examples of applying CQI in their area of interest. Following the lectures but before the practicum students' mean exam score on the 3 CQI questions was 83%. Following the practicum exercise the mean score for the 7 CQI questions improved to 97.4%	

5.4 Narrative Synthesis

5.4.1 Teaching Approaches

As Table 2 and 4 illustrate, teaching approaches were combined on most occasions with experiential learning. Didactic sessions were reported in seven studies, group work in four and seminars in three. Other approaches included self-directed learning and simulation.

Experiential learning: This arose whereby medical students applied improvement methodology to enhance their individual patient *'history taking skills'* (Ogrinc et al., 2007). Similarly, nursing students undertook an eight week personal improvement project as a way of facilitating the transfer of quality improvement knowledge from a personal to professional context (Kyrkjebo, 2006) and pharmacy students conducted a hypothetical quality improvement '*practicum*' which involved problem identification from the evidence-base (or a personal topic), design of measures and a proposal for solutions (Skledar and McKaveney, 2009).

Students also moved beyond the classroom to engage clinically in quality improvement activities. This involved observational activities within care homes, medical and surgical wards whereby nursing students used process maps to document patient journeys through the healthcare system (Kyrkjebo et al., 2001; Kyrkjebo, 2006). Patient stories were collected and analysed as a way of identifying improvement opportunities. Students selected quality improvement tools for problem-solving, later reflecting upon these during Action Learning Sets with clinical mentors (Christiansen et al., 2010). Other nursing students encountered more comprehensive experiences involving small-scale improvement projects as the basis for their dissertation (Baillie et al., 2014) or compulsory assignment (James et al., 2016). Here, real time data were collected and quality improvement tools utilised to identify problems. Small tests of change using Plan-Do-Study-Act cycles were conducted and subsequent project reports and reflective accounts written up for assignment submission.

Clinical opportunities also arose for medical students to identify a quality gap during a yearlong clinical rotation which involved performing a literature review, developing appropriate

measures and forming a plan for collecting readily available data (Levit et al., 2012). Others collected real time data through clinical surgical safety audits in the operating room (Gonsenhauser et al., 2012) or from extracting data from patients' diabetes charts at primary care practices. Here, students implemented improvement interventions and followed up results six months later (Gould et al., 2002).

Didactic learning: Session content and duration varied, yet, over half of the studies introduced quality improvement through didactics. Content included person/patient centred care, theories and concepts of improvement (Gould et al., 2002; Gonsenhauser et al., 2012; Baillie et al., 2014; Kyrkjebo, 2006; Skledar and McKaveny, 2009; James et al., 2016), quality indicator measures and differences between improvement and research (Gould et al. 2012; Skledar and McKaveney, 2009). Some studies focussed on improvement methodologies such as Model for Improvement, Plan-Do-Study-Act, root cause analysis, FOCUS/Plan-Do-Check-Act or process and systems thinking (Christiansen et al., 2010; Baillie et al. 2014; Skledar and McKaveney, 2009; James et al., 2016) while others included specific quality improvement tools such as process mapping (Baillie et al., 2014), pareto charts, run charts, cause/effect diagrams and bar graphs (Kyrkjebo, 2006; James et al., 2016). Broader contextual topics included inter-professional learning and working, leadership and patient safety (Christiansen et al., 2010; James et al., 2016), personal and organisational development (Christiansen et al., 2010), clinical governance and management of change (Christiansen et al., 2010; Gould et al., 2002; Skledar and McKaveney, 2009), evidence-based practice and resilience (James et al., 2016).

Didactic approaches were supplemented with workbooks, podcasts, question and answer sessions or resource lists which signposted students to further information e.g. quality indicator measures (Christiansen et al., 2010; Kyrkjebo, 2006; Skledar and McKaveney, 2009; James et al., 2016). Clinical expertise was used to introduce public and patient participation through Service User experience videos (Christiansen et al., 2010), exemplar accounts of national initiatives (James et al., 2016) or from students previously involved with quality

improvement (Skledar and McKaveney, 2009). Number and duration of didactics varied from one-three sessions, lasting one-two hours over two-four months (Gould et al. 2002; Baillie et al., 2014; Skledar and McKaveney, 2009). However, one study integrated in excess of 10 over a three year programme excluding workshops and e-learning (James et al., 2016).

Seminar/*Group Work/Workshops*: These were used to undertake formal training in data extraction from diabetic patients charts (Gould et al., 2002) and to feedback student observations following process mapping exercises in practice (Kyrkjebo, 2006). A few interventions adopted group work/workshops as a way of delivering education (James et al., 2016, Ogrinc et al., 2007), undertaking clinical quality improvement activities (Kyrkjebo et al., 2001), completing quality improvement practicum assignments (Skledar and McKaveney, 2009; James et al., 2016) or as a way of offering support (James et al., 2016).

Self-directed e-learning: Both medical and nursing students were introduced to the Institute of Healthcare Improvement e-learning modules (Gonsenhauser et al., 2012; James et al., 2016). Medical students completed two hours of self-paced study on topics such as quality improvement, patient safety, leadership, teamwork and person-centred care (Gonsenhauser et al., 2012) whereas nursing students completed 14 compulsory modules which were integrated throughout their 3 year curriculum (James et al., 2016).

Simulation: A 2.5 hour simulation session was adopted to orientate students to an operating room protocol and etiquette in preparation for their experiential learning activity. This involved role-playing to familiarise students with the use of a surgical safety checklist audit tool (Gonsenhauser et al., 2012).

5.4.2 Impacts of teaching approaches

Kirkpatrick Level 1: Student reactions towards learning experiences were mixed yet most related to 'timing'. Nursing and pharmacy students felt their programme was not well integrated (Kyrkjebo, 2006) or was delivered at an inappropriate time (Skledar and McKaveney, 2009). They expressed the need for more time to ask questions (Skledar and McKaveney, 2009), more time in practice (James et al., 2016; Ogrinc et al., 2007), wishing they had attributed more time for preparation (James et al., 2016), more protected time for projects (Kyrkjebo, 2006; Levit et al., 2012), challenges of time in selecting a topic (James et al., 2016) and reducing time for didactic sessions (Ogrinc et al., 2007) and yearlong projects (Levit et al., 2012). Other reactions related to the initial apprehension of using quality improvement tools and terminology, perceived lack of autonomy at pre-registration level (James et al., 2016) and the need for structured goal setting and guidance (Levit et al., 2012). Frustrations arose from one student stating *'it's more important to involve students in the design and analysis than simply the data collection, which is just labor'* (Gould et al., 2002).

Positive reactions also emerged following quality improvement education. Medical students appeared satisfied with their programme whereby 83% had time to complete projects and 62% felt that expectations of them were clear (Gould et al., 2002). Student nurses were positive and felt that observing patients was 'quite useful', working in groups was to a 'large extent' useful and introductory sessions being 'most useful' (Kyrkjebo et al., 2001). Some appreciated having time during holidays to consider a topic, grateful for the opportunity to do quality improvement and enjoyed it more than expected (James et al., 2016). Learning appeared evident with one student realising that: *'small changes can make a big difference ….. previous to starting this project I was unaware of how as a student I could help to achieve change'* (James et al., 2016).

Kirkpatrick Level 2: Despite no improvement in medical students Observed Structured Clinical Examinations, the intervention group were best able to apply principles of quality

improvement on a skills based exam compared with the control group (Ogrinc et al., 2007). However, less than half felt satisfied in identifying best practice from the literature, developing aims or using small cycles of change, and over half failed to see any patient benefits. Similarly, in the self-directed yearlong clinical rotation (Levit et al., 2012), there was no significant improvement in medical student' knowledge, after which they were unable to define measures or apply timely goals.

Contrastingly, knowledge increased significantly for other medical students following their training (Gould et al., 2002; Gonsenhauser et al., 2012). Firstly, this was established where medical students were exposed to organised audits within the operating room (Gonsenhauser et al., 2012), in which they felt better prepared to report errors and contribute to improvement post intervention, and secondly students undertaking data extraction of diabetic patients information from their charts, *agreeing* or *strongly agreeing* that decisions in practice should be based upon data (Gould et al., 2002).

Nursing students' knowledge of quality improvement also increased following an activity to map the patients' healthcare journey (Kyrkjebo et al., 2001). Here, 58% knew the meaning of quality improvement concepts from being in practice alone despite having no quality improvement theory beforehand. However, 71% were still *unaware* or *didn't know* of any quality improvement related activity ongoing in the ward. Others conducting service improvement (SI) projects for their dissertation rated their own knowledge higher compared to the control group (demonstrating statistical significance) (Baillie et al., 2014), and similarly following an opportunity to be in practice (Kyrkjebo, 2006) authors reported an increase in students' knowledge of the patients' needs.

Pharmacy students (87%) valued their '*practicum*' assignment above lectures alone and mean examination scores increased from 83% following the lectures, to 97.4% when re-tested after the hypothetical '*practicum'* (Skledar and McKaveney, 2009). Most (97%) were able to provide examples of applying improvement in their area of interest and demonstrated positive

attitudes towards quality improvement, rating it *important* to have knowledge of quality improvement and regarding it *highly relevant* for their later career.

Attitudes were positive in all professions. In medicine, perceived confidence to be involved in quality improvement and a significant increase in its value was established following clinical exposure, despite no improvement in knowledge (Levit et al., 2012). Nursing students considered SI to be *very important* or *important* in relation to patient safety and the individuals' healthcare experience (Christiansen et al., 2010) and 56% of those conducting SI felt *very confident* or *confident* to be involved (Baillie et al., 2014). One student found it *'invaluable for current practice and* (their) *later professional career'* while others *'had a new motivation for quality improvement …. something* (they) *would take seriously as a staff nurse and not shy away from again'* (James et al., 2016).

Kirkpatrick Level 3: The review identified no studies focussing on quality improvement related behaviour change within this population.

Kirkpatrick Level 4: One study (Gould et al., 2002) measured patient outcomes, identifying an increase in foot and eye exams for patients with diabetes from 51% to 70%. Authors suggest combining teaching approaches (didactic, seminar and experiential learning) gave medical students greater appreciation of the impact of improvement activities on patient outcomes.

5.4.3 Enabling and impeding factors

As illustrated in Table 4, five themes were identified which included: teaching approaches, clinical/faculty support, information provision, curriculum balance and quality improvement data.

Teaching Approaches

Enabling: Students privy to experiential learning (Kyrkjebo et al., 2001; Baillie et al., 2014; Kyrkjebo, 2006; Skledar and McKaveney, 2009) were able to consider quality improvement within a real life setting which enabled students to listen to patients/service users and carers. Different perspectives of quality care could be gained which gave students an

appreciation of how quality improvement impacts the patient experience. It also assisted in development of improvement ideas (Kyrkjebo et al., 2001; Baillie et al., 2014; Kyrkjebo, 2006; Skledar and McKaveney, 2009; James et al., 2016). Experiential learning reinforced the nature of utilising quality improvement tools for problem solving, enhancing understanding of quality improvement principles, emphasising the unpredictable nature of change and highlighting the necessity to obtain staff participation and feedback (Kyrkjebo, 2006; Skledar and McKaveney, 2009; James et al., 2016). Moreover, nursing students felt the *mandatory* nature of quality improvement teaching was enabling (Baillie et al., 2014) in that 85% felt Action Learning Sets enhanced their learning (Christiansen et al., 2010). Medical students benefited from the Institute of Healthcare Improvement e-learning being free (Gonsenhauser et al., 2012).

Impeding: Medical students felt the lack of practical opportunities impacted their learning and expressed a need to focus here in future (Ogrinc et al., 2007). They were concerned about receiving inadequate preparatory didactics and felt that working in pre-selected groups was more difficult (Levit et al., 2012). Likewise, nursing students' attitudes were affected as they failed to establish the point of identifying and analysing problems, if learning was not transferred to practice (Kyrkjebo, 2006).

Clinical and Faculty Support

Enabling: Almost half the nursing degree students rated support from personal lecturers, practice educators or link tutors most helpful (Baillie et al., 2014), a few attributing success of their '*practicums'* to keen placement mentors (James et al., 2016). Similarly, mentor support in practice was the difference between a developed or underdeveloped project for medical students (Levit et al., 2012). In the former, students managed to seek an *'actively engaged'* mentor throughout the project whereby face-to-face meetings and emails were shared.

Impeding: In contrast, medical students became frustrated with the difficulty in finding a mentor to guide their projects (Levit et al., 2012). They felt support was variable depending on the clinical site visited and that a disorganised environment hindered their projects. Clinical sites

appeared reluctant to allow medical students to implement significant changes (Skledar and McKaveney, 2009) with one student stating *'I felt like I was invading without permission'.*(Gould et al., 2002) Similarly, mentors of nursing students lacked awareness of the projects at all, instead perceiving students quality improvement activity as threatening asking '*is there something wrong here?'* (Kyrkjebo, 2006). Student nurses rated insufficient resources (staff and time) in practice the biggest barrier (Baillie et al., 2014).

Academic mentorship was equally unsupportive and low priority was given to supporting nursing students during participatory quality improvement counselling sessions. Faculty was reported to lack quality improvement expertise and unable to guide students. *'Ugh not this again'* was a comment made which may have reduced students own motivations for the programme (Kyrkjebo, 2006). Other faculty challenges related to lack of understanding of training content (Baillie et al., 2014) and working out the logistics of fitting the module into the curriculum without it feeling like an add on (Ogrinc et al., 2007).

Information Provision

Enabling: Supporting materials such as workbooks were useful for nursing students (Kyrkjebo, 2006) and a list of topics and references to refer to helped pharmacy students select project ideas (Skledar and McKaveney, 2009). Student clarity was enhanced through structured guidelines which reduced confusion; *'it was hard to feel overwhelmed or lost in the process'* (James et al., 2016). Exemplar work conducted by previous students, listening to real life scenarios and having access to mock examples of projects were all considered beneficial (Kyrkjebo et al., 2001; James et al., 2016), as were small counselling groups, support sessions and Action Learning Sets for information exchange (Baillie et al., 2014; Kyrkjebo, 2006; James et al., 2016).

Impeding: Medical students considered their materials irrelevant and more appropriated to 3rd year students which made the module vague and confusing (Ogrinc et al., 2007). A lack of clear concepts during introductory sessions led to student nurses having poor understanding of

the task to be undertaken in practice, making it difficult to inform staff of what they were meant to be doing (Kyrkjebo, 2006). A need for more project examples from nursing and medical students were expressed (Kyrkjebo, 2006; James et al., 2016).

Curriculum Balance

Impeding: Balancing the quality improvement workload within the medical curriculum presented challenges and the efficiency of time was questioned, given competing educational demands (Gould et al., 2002), or where schedules were already full (Levit et al., 2012). Students and course leaders agreed there '*was no need to dedicate the amount of time required* (for quality improvement) *during already harried sessions'* instead viewing these additional topics as '*extraneous'* (Ogrinc et al., 2007). Similarly, nursing students undertaking SI projects rated time as most hindering (Baillie et al., 2014). This is possibly why in another study they were told to work on projects when *'more important tasks'* were complete (Kyrkjebo, 2006). Students were expected to pick project topics within their first 2 weeks in practice yet they expressed need during that time to familiarise themselves with the environment and potential learning opportunities at hand (James et al., 2016). Nursing students didn't prioritise quality improvement education over subjects relating to pathology, nursing and examinations (Kyrkjebo, 2006), or for medical students, aspects of their careers that were more *'pressing'* (Gould et al., 2002). Other issues raised related to the duration of quality improvement education being too lengthy (Levit et al., 2012), elongated sessions that could have been condensed (Ogrinc et al., 2007) and the impact of the projects being interrupted by holidays, making it difficult to form groups (Skledar and McKaveney, 2009) or collect data (Kyrkjebo, 2006).

Data

Impeding: Students lacked information about where to collect data (Skledar and McKaveney, 2009), some perceived data to be tedious, uninteresting, boring or non-educational and irrelevant (Gould et al., 2002).

6. Discussion

Pre-registration healthcare professionals are required to demonstrate competence in quality improvement methodologies prior to registration (NMC, 2010; Academy of Medical Royal Colleges, 2016). Our review set out to identify, describe and analyse teaching approaches used within this population to inform educational providers. The ten studies retrieved were subject to the same limitations reported by Windish et al. (2009) in their systematic review of methodological rigour in quality improvement curricula. This included poor reporting, lack of valid tools and restrictive evaluation methodologies. We therefore offer only a summary of the best available evidence while highlighting areas requiring attention.

The teaching approaches included experiential learning, didactics, seminars, group work, e-learning and simulation. As expected, Kolb's (1984) experiential learning combined with didactics was most prevalent and consistent with previous research (Boonyasi, 2007), as was the variety in quantity and content of didactic lectures (Jeffs et al., 2013; Creswell et al., 2013). Only two studies in the review, however, reported their approaches sufficiently for replication (James et al., 2016, Kyrkjebo, 2006) which strengthens the current evidence of the need to develop sound reporting standards in quality improvement educational research (Windish et al., 2009). Currently, SQUIRE guidelines for reporting quality improvement work in practice are available; yet they do not cater for educational intervention (Ogrinc et al., 2008). A guideline that acknowledges both contexts, in which quality improvement education is viewed upon as complex would be useful. The multiple components of quality improvement education, one of which is the teaching approach adopted, are what contribute to its complexity (MRC, 2008). Exploring such components is beyond this review. However, the faculty, the learner, the clinical setting, the inter-professional team, the patient and the quality improvement endeavour itself all contribute to the programme's outcomes (Jones et al., 2014). These components are in and of themselves complex. For example, learners may also be affected by their own intrinsic or

extrinsic motivations (Bengtsson and Ohlsson, 2010), their own sense of value, or indeed their own perceived acceptance from their peers (Levet-Jones et al., 2009). The clinical setting; which itself comprises the physical space, the psychosocial and interaction factors and the organisational culture (Flott and Linden, 2016) also contribute. To search for causality within educational research is therefore '*to search for the holy grail'* (Morrison and Van der Werf, 2016 p.1), hence the difficulty in attributing teaching approaches to educational, behavioural or organisational outcomes.

We explored evaluative outcomes using the Kirkpatrick Evaluation Model (2009) as a comparator to the wider education literature. Most studies reported outcomes at Level 1 (reaction) and Level 2 (skills, knowledge or attitudes). While these levels are generally easier for faculty to evaluate, only one validated tool (QIPAT-7) was reported for skill acquisition (Levit et al., 2012). Knowledge was assessed using the QIKAT tool (Ogrinc et al., 2007) although a recently revised version (QIKAT-R) asserts stronger validity and reliability (Singh et al., 2014). More studies reporting the utility of these tools in larger samples across disciplines would be useful in recommending their uptake more generally.

Measuring Level 3 (behaviour) and Level 4 (impact) in which only one study in the latter was found, is difficult. Firstly, pre-registration healthcare professionals require sufficient opportunity in clinical contexts to allow their knowledge and skill to become what Lucas describes as *'routine habits of action*' (Health Foundation, 2014). No studies reported their intent to conduct longitudinal evaluation of behaviour once individuals qualified. Catalysing such activity may require clarity of which behavioural competences are priority. The Scottish National Health Service explicate that all staff contribute to team-based PDSA cycles, collect data and collaborate with other QI projects (NHS Scotland, 2011). The UK Nursing and Midwifery Council competencies (NMC, 2010) are slightly more ambiguous, however, these are being reviewed. Clarification may help to standardise quality improvement education and reduce variety established between faculties (Creswell et al., 2013). Secondly, the ultimate goal to improve

patient care or services (Level 4) is challenging not only because of similar complexities shared with education but because of poor research design. Attempts to evaluate patient care in education studies have resorted to reporting Level 2 outcomes instead (Starr et al. 2016). Our review identified one study which reported improvement in patient processes using pre/post methods, however, these simplistic measures assume causal linkage between educational intervention and outcome, discounting the importance of contextual factors in practice (Bates, 2004), which is instead the very antithesis of quality improvement.

Understanding contextual factors in quality improvement, defined as *'anything not directly part of the technical QI process that includes the QI methods themselves and the clinical intervention'* (Kaplan et al. 2010 p502) is a pre-requisite for establishing why success ensues in one setting and not in another (Health Foundation 2014, Kaplan et al. 2010). While no studies explicitly considered '*contextual factors'* in their interpretation process, establishing which ones are related to faculty and practice, and which ones are modifiable, are important for planning quality improvement educational activity (Van Hoof and Meehan, 2011). Factors that the review established that enabled or impeded delivery of quality improvement education were similar to previous research (Tella et al. 2013; Creswell et al., 2013) and included teaching approaches, clinical/faculty support, information provision, curriculum balance and data. While exploring these (and other) contextual factors was not an objective of the review, future studies should look beyond to the improvement science literature where a great deal of focus already exists. Here, factors alluding to change in practice are theoretically depicted and comprise leadership, organisational culture, change management, human factors, clinical engagement and evaluation (Greenhalgh et al., 2004, Kaplan et al., 2010). Consideration of such factors, as well as those identified in this review, are important for faculty developing and evaluating educational interventions. We recommend a collaborative approach with clinical colleagues who support quality improvement learning in practice, and in doing so adopt ethnographic enquiry.

Ethnography has become more prominent within the healthcare education literature recently (Goodson and Vassar, 2011) and involves knowing and understanding human behaviour within the cultural context in which it occurs (Omery, 1988). It *moves beyond the selective perceptions of others'* (Patton 2002 p264) and is acknowledged for being '*especially good at probing into areas where measurement is not* easy' (Dixon-woods, 2003). Ethnography involves immersion within the social setting for prolonged periods to observe, interpret and report upon the behaviours and interactions which occur (Bryman 2001, Delamont 2007). Its defining feature is the settings *'thick description'* (Geertz, 1973) upon which interpretation is based and could assist faculty exploring the contextual factors that impact quality improvement education in practice. It may be particularly useful, for example, to establish how different clinical settings affect the student's learning, motivations and/or relationships with the wider team, especially given that quality improvement expertise in most practice settings will be, unusually, driven by the student themselves.

7. Limitations

Our review had limitations. Firstly, due to resources, only articles in English were retrieved excluding those, should there be any, in another language. We included studies that explicitly reported the utility of pre-determined improvement models (Powel et al., 2009) which may have excluded worthwhile studies. For example, where students undertook audit as part of a larger improvement project, yet the details of which were not reported in the paper. Our screening process, however, did not identify any studies which indicated this. Overall, the review team minimised bias by developing and adhering to a study protocol which should strengthen the quality and reliability of evidence found regardless (Campbell Collaboration, 2001).

8. Conclusion

Evaluating quality improvement education in which multiple components exist is complex. Experiential learning combined with didactics is generally the favoured approach; however, attributing causality to educational intervention proves difficult in light of poor methodological rigour, lack of validated tools and complex healthcare environments. Based on these findings, clarity regarding which quality improvement competencies are priority for this population would be useful to streamline future educational development and evaluation. A stronger collaborative approach between educators and clinicians is recommended to explore the contextual factors associated with quality improvement education in this population. Ethnographic research would be a logical next step to advance the field.

Additional Files

Additional File 1. Quality and Relevance Appraisal Tool Scoring Criteria and Allocation and REPOSE Data Extraction template

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