TITLE: Which Learning Activities Enhance Physical Therapist Practice? Part 1: Systematic Review and Meta-analysis of Quantitative Studies

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AUTHOR BYLINE: Edmund Leahy, Lucy Chipchase, Marlena Calo, Felicity C. Blackstock

AUTHOR INFORMATION:

E. Leahy, BPhysio, MPhty(Musc), Department of Physiotherapy, School of Science and Health, Western Sydney University, Campbelltown, New South Wales, Australia; Department of Rehabilitation, Nutrition and Sport, School of Allied Health, La Trobe University, Bundoora, Victoria, Australia; and Physiotherapy Department, Northern Health, Epping, Victoria, Australia. Address all correspondence to Mr Leahy at: 18772874@student.westernsydney.edu.au.

L. Chipchase, PhD, Department of Physiotherapy, School of Science and Health, Western Sydney University and Faculty of Health, University of Canberra, Canberra, Australia.

M. Calo, PT, BPhysio, PGCert(PFPhysio), Department of Physiotherapy, School of Science and Health, Western Sydney University and Department of Rehabilitation, Nutrition and Sport, School of Allied Health, La Trobe University.

F.C. Blackstock, PhD, Department of Physiotherapy, School of Science and Health, Western Sydney University.

Objective. Following graduation from professional education, the development of clinical expertise requires career-long participation in learning activities. The purpose of study was to evaluate which learning activities enhanced physical therapist practice.

Methods. Eight databases were searched for studies published from inception through December 2018. Articles reporting quantitative data evaluating the effectiveness of learning activities completed by qualified physical therapists were included. Study characteristics and results were extracted from the 26 randomized controlled trials that met the inclusion criteria. Clinician (knowledge, affective attributes, and behavior) and patient related outcomes were extracted.

Results. There was limited evidence that professional development courses improved physical therapist knowledge. There was low-level evidence that peer assessment and feedback was more effective than case discussion at improving knowledge (SMD = 0.35, 95%CI = 0.09-0.62). Results were inconsistent for the

effect of learning activities on affective attributes. Courses with active learning components appeared more effective at changing physical therapist behavior. The completion of courses by physical therapists did not improve patient outcomes; however, the addition of a mentored patient interaction appeared impactful.

Conclusions. Current evidence suggests active approaches, such as peer assessment and mentored patient interactions, should be used when designing learning activities for physical therapists. Further high-quality research focused on evaluating the impact of active learning interventions on physical therapist practice and patient outcomes is now needed.

Impact. This study is a first step in determining which learning activities enhance clinical expertise and practice would enable the physical therapy profession to make informed decisions about the allocation of professional development resources.

The development of expertise requires physical therapists to be adaptive learners with a career-long commitment to identifying and addressing gaps in knowledge and skills through the use of meta-cognitive reflection and critical thinking.[1-3] Continuing professional development (CPD) is essential for the adaptive learner and has been classified into formal and informal learning activities by registration bodies and previous researchers.[4] Learning is a consequence of how learners interpret and respond to the experience of learning activity participation.[5] Formal learning activities are structured and may be facilitated by an educator, such as a professional development course or conference.[4] Informal learning activities are unstructured, such as independent reflection on experience or workplace experiential learning.[4] Formal learning activities can provide learning support,[4] however barriers such as cost and time can prevent participation.[6] Informal learning activities are more accessible than formal activities, however are reliant on physical therapists exhibiting features of a master adaptive learner such as self-motivation, self-regulation and meta-cognition.[2,3]

Determining which learning activities are effective would enable the physical therapy profession to make informed decisions regarding where to allocate limited time and resources to enable career-long learning. While previously published reviews provide some value,[7-12] they are limited for a number of reasons. Of note, many reviews were not physical therapy specific.[8-10,12] In addition, these reviews excluded qualitative research,[7-11], omitted informal CPD[7-12] or were limited to the translation of research into practice,[7,12] and thereby did not encompass the breadth of CPD. A focused systematic review of post-professional physical therapy education is required which encompasses both formal and informal learning activities and includes qualitative research.

The aim of this systematic Quantitative (Part A) review was to address this gap in the current literature by evaluating the quantitative data that answered the question 'Which learning activities enhance physical therapy practice?' Understanding why certain learning activities

are effective is essential for the future of physical therapist professional development and requires consideration of the physical therapist learner's perspectives in conjunction with learning theory and research. Hence, the importance of the Qualitative (Part B) review [13] which explored the physical therapist learners' experiences, beliefs and attitudes and is published as a companion paper.

[H1] Methods

This systematic review is the first in a 2-part series based on a published protocol[4] and was registered on the International Prospective Register of Systematic Reviews (PROSPERO CRD42016050157). A brief outline of the methods with rationale for amendments is provided below.

[H2] Data Sources and Searches

Ovid MEDLINE, EMBASE, AMED, CINAHL, PsycINFO, PEDro, Cochrane library and ERIC were searched to December 2018. The search strategy used the concepts of (1) physical therapist, (2) learning activities and (3) physical therapist, or patient outcomes. An example of a full search strategy is provided in the protocol paper[4] and Supplementary Appendix 1. Reference lists of included studies were also searched as per the protocol.[4] A citation search was completed for included studies using the Science Citation Index Expanded via the Web of Science database.

[H2] Study Selection

Full details of the study selection criteria have been described previously.[4] In brief, studies were eligible if they were a randomized controlled trial (RCT) that was published in peer reviewed journals, a higher degree dissertation, and was in English. The review was limited to RCTs as this study design is least likely to provide biased estimates of effects or result in systematic error.[14-17] Included studies needed to have qualified or licensed physical therapists

as the participant learner, formal or informal learning activities as the education intervention and either participant learning outcomes or patient outcomes. Included studies needed a comparison group with no education intervention (control) or a different education intervention.

After removal of duplicates, 2 independent researchers screened titles, abstracts and full texts for inclusion. (E.L., and F.B., L.C. or M.C.). Disagreements were resolved through discussion or by a third reviewer (F.B. or L.C.).

Studies were grouped based on study design for data extraction, risk of bias assessment and results synthesis. Quantitative studies are reported in the current Quantitative (Part A) review, with qualitative studies reported separately in the Qualitative (Part B) review.[13]

[H2] Data Extraction and Quality Assessment

Study characteristics extracted are outlined in the review protocol.[4] Point estimates, measures of variability, sample size, between group difference statistics and statistical significance findings were extracted where possible. Data was extracted (E.L) and then verified by a second researcher (M.C.).

Risk of bias was assessed using the PEDro scale.[4,18,19] The PEDro scale consists of 11 items, 10 of which address risk of bias. Items 4, 6 and 7 were adapted as the learning activity targeted physical therapists rather than patients. Baseline comparability (item 4) was required for physical therapist and patient outcomes. Where patient outcomes were analysed, change in outcomes needed to be assessed prior to the learning activity intervention, and be comparable at baseline to satisfy this criterion. Change in patient outcomes following the learning activity was not required to be from the same patients as those assessed at baseline. To satisfy baseline comparability (item 4), patient outcome scores in each group needed to be comparable pre-physical therapy treatment. In addition, change in patients' outcomes (ie, pre

and post physical therapy treatment) prior to learning activity intervention in each group needed to be comparable.

For subject blinding (item 6), physical therapists needed to be masked to the learning activity intervention and, where appropriate, the patients also needed to be masked. For therapists' blinding (item 7), the educators providing the learning intervention were considered the 'therapists' and needed to be masked to the learning activity comparison. Two reviewers (E.L., M.C.) independently rated included studies, with disagreements resolved through discussion or a third reviewer (F.B.).

[H2] Data Synthesis and Analysis

Grouping of data was by outcome (patient outcomes or therapist outcomes) and learning activity. Patient outcomes were a change in patient health status measured by reliable and valid measures for the specific patient group. The patient outcome grouping had additional subgroups that were disability, pain and quality of life (Suppl. Appendix 2).

Physical therapist outcomes were related to changes stimulated by learning following an educational intervention and grouped into knowledge, affective attribute or behavior categories (Suppl. Appendix 2). Knowledge was defined as the ability to remember and apply information such as facts and procedures [20] reflected in Blooms taxonomy as "remembering", "comprehending" and "applying.[21]" Changes in knowledge could be evaluated through questionnaire or responses to a clinical vignette. Affective attributes were defined as physical therapists' attitudes and beliefs. These could be evaluated using questionnaires asking about attitudes towards evidence-based practice, or using validated outcome measures such as the Self-Reflective and Insight Scale.[22] Behavior was considered to be what a physical therapist does during a clinical interaction. An example of evaluating behavior includes participation in evidence-based practice activities, such as searching for evidence or critical appraisal

during clinical work.[23] Other examples included adherence to guidelines or the use of specific outcome measures during patient encounters.[7] Behavior could be measured using self-report questionnaires, diaries, documentation audit or observations of physical therapist interactions with patients.

Learning activities were thematically grouped based on the description of activities participants completed. Examples of learning activity groupings included peer assessment, group discussion and courses. Courses could vary from hours to months in duration. In addition, courses were further classified as face-to-face, online or blended. Courses using face-to-face delivery were classified as 'course'. Those classified as 'online course' used technology to support learning with no face-to-face component. Courses with both online and face-to-face components were classified as a 'blended course'.

Where a comparison group did not experience an alternate learning activity, then this was considered a control group. Learning activities such as distribution of guidelines or those with different intended learning outcomes were not considered control groups, rather comparison learning activities.

Where sufficient data were available from multiple studies, a meta-analysis using Review Manager 5.3 software was completed. A standardized mean difference (SMD) effect size was calculated for outcomes used in the meta-analysis. SMD values of 0.2, 0.5 and 0.8 indicated small, moderate and large effect sizes respectively.[24] I^2 was used to assess statistical heterogeneity, with 25% considered as low, 50% as moderate and 75% high.[25]

The Grading of Recommendations Assessment, Development and Evaluation (GRADE)[26] approach was used to assess the strength of the evidence for each meta-analysis. All studies commenced with the score of four, as they were randomized controlled trials. Grading used the following predefined criteria for downgrading of studies:

(1) *Risk of bias*: PEDro score less than 6.[27,28]

(2) *Inconsistency*: I^2 score greater than 25%.[25]

(3) *Precision*: confidence intervals crossed the clinical decision threshold between recommending and not recommending and intervention[29]. The clinical decision threshold for the precision criteria was set at moderate effect of 0.5.[24]

(4) *Directness*: differences in intended learning outcomes of the learning activity or outcome measures used across studies.

(5) *Publication bias*: strong suspicion of the study being repeated in another publication or likely to be industry sponsored.[30]

Evidence quality was graded as high (4), moderate (3), low (2), or very low (0 to 1). When the GRADE approach was not possible due to the presence of only one study, then this was reported as limited evidence.

Results were not combined in a meta-analysis if baseline characteristics had not been assessed. While randomization should minimize the possible variability in baseline characteristics of participants, this is not guaranteed.[17] Therefore, a meta-analysis that included participants not comparable at baseline could provide misleading results. Further, in the presence of significant variability in learning activity delivery methods and outcome measures, results were not aggregated. Differences in course content focus (eg, evidence-based practice compared with back pain pathophysiology) were not considered to be significantly variable for this review. Descriptive analysis of results was performed where meta-analysis and the GRADE approach was not possible.

[H2] Role of the Funding Source: The funder played no role in the design, conduct, or reporting of this study.

[H1] Results

Searching identified 6994 unique articles. Following title and abstract screening, 6580 articles were excluded. After the full text screening, 88 quantitative full-text articles reporting on 88 unique studies were included (PRISMA Flow diagram Figure).

Of the included articles, 80 used quantitative methods only, while 8 used mixed methods. There were 26 RCTs, 6 controlled trials, 47 pre-post cohort studies, 4 cohort studies and 6 cross-sectional studies. This paper reports on the results of the 26 RCTs (Tab. 1). For transparency, the characteristics of the other quantitative studies are included in Supplementary Appendix 3. Across the RCTs, there were 9 different learning activities identified, most common being courses (16 studies), reminders (5 studies) and blended courses (4 studies) and online courses (3 studies).

PEDro scores of the 26 RCTs ranged from 3 to 8 with a median score of 6 (Suppl. Appendix 4). The criteria not satisfied in most studies were allocation of concealment (17 articles), blinding of participants (20 articles), educators (26 articles) and assessors (18 articles). Risk of bias, inter-rater risk agreement was good with 87.06% observed agreements (Kappa = 0.721, Confidence interval (CI) 0.638, 0.805).

[H1] Therapist Outcomes

Twenty studies reported therapist outcomes.[31-44 43,45-50] Results for therapist outcomes are summarized in Table 2 and Table 3. Ten studies compared a professional development learning activity to control[31-40] while ten compared 2 different learning activities.[41-50] Meta-analysis and GRADE synthesis was not possible in the majority of cases due to significant

variability in learning activities and outcome measures used. Only 2 meta-analyses and GRADE syntheses were possible for the comparison of peer assessment and case discussion learning activities related to knowledge and the affective attribute of reflection.

Of the studies comparing intervention to control, 3 of the learning activities were blended courses,[31,35,36] 2 were online courses,[37,38] 4 were face-to-face courses.[32,34,39,40] Five studies assessed the outcome of knowledge[35-38,40], 2 affective attributes[34,35], and 6 behaviour.[31-33,35,39,40]

Of the 10 studies comparing 2 or more different interventions, the learning activities were face-to-face courses, online courses, peer assessment, group discussion, guideline dissemination and interactive workshop (Tab. 3). Variations of courses were studied such as using an additional follow up day[41] or mentored patient session,[51] comparing learning outcome specific courses to courses addressing an unrelated area[47] or more general education,[42] and using tutors with differing expertise.[43]

Twenty-four outcome measures were used. There were 8 outcome measures for knowledge, 5 for affective attributes and 12 for behavior. Nine outcome measures had acceptable pre-tested, psychometric properties. Sixteen were bespoke, designed specifically for the study. Of these, some studies assessed effects on multiple outcome measures for the same outcome without an overall summary effect size. For example, one study evaluated the self-reported frequency of 21 different treatment behaviors completed by physical therapists.[41] One outcome measure was an alteration of a previous psychometrically tested outcome measure. Table 2 specifies the outcome measures used by each study and summarizes the results.

PEDro scores for studies comparing learning activities to control for therapist outcomes, ranged from 3 to 8 with a median of six. For studies comparing 2 different learning activities, PEDro scores ranged from 5 to 8 with a median of six.

[H2] Impact on Knowledge

[H3] *Learning activities compared to control*

Five studies evaluating face-to-face, blended and online courses were found to be effective at improving knowledge compared to no intervention (Tab. 3).[35-38,40]

[H3] *Comparing learning activities*

A meta-analysis (Suppl. Appendix 5) and GRADE approach found very low level evidence from 2 studies that peer assessment was more effective than case based discussion at improving clinical decision making knowledge, assessed by case vignettes[49,50] (Tab. 3). Downgrading was due to risk of bias (average Pedro score=5.5), consistency (I^2=0), precision (confidence interval crossing 0.5) and directness (differences in learning outcomes and outcome measures used).

No differences in knowledge were found when comparing online to face-to-face teaching,[46] or when comparing interactive workshops with a conventional course.[44] A face-to-face course was effective at improving whiplash knowledge compared to disseminating guidelines.[45]

[H2] Impact on Affective Attributes

[H3] *Learning activities compared to control*

There were inconsistent results for an education intervention's effect on the attitudes and beliefs of physical therapists. In one study, a face-to-face course did not change physical therapists' affective attributes, as measured by the Health Care Providers Pain and Impairment Relationship Scale, but did change attributes as measured by the Pain Attitudes

and Beliefs Scale for Physiotherapists, biomedical and biopsychosocial scales.[34] A blended course did not change physical therapist attitudes towards evidence-based practice.[35]

[H3] *Comparing learning activities*

A meta-analysis (Suppl. Appendix 5) and GRADE approach found low level evidence of no difference in reflective practice when peer assessment was compared to group discussion.[49,50] Downgrading was due to risk of bias (Median PEDro=5.5) and directness (different education content).

No differences were found in biopsychosocial attitudes when a face-to-face course was compared to an online course, however an online course had a larger change in biomedical attitudes.[46] No differences were found when a region specific course (ie, back pain) was compared to a different region specific in-service program.[48]

[H2] Impact on Behavior

[H3] *Learning activities compared to control*

Three studies found that face-to-face courses were effective at changing physical therapist behaviour.[32,39,40] However, for blended courses, 2 studies[31,33] found no effect while one study reported being effective at changing behavior.[35]

[H3] *Comparing learning activities*

For behavior, 7 studies compared the effect of one education intervention to another.[41-47] These studies found no differences in physical therapist behavior when a course with an expert tutor was compared to one with a non-expert tutor,[43] when an additional follow up day was added to course,[41] or when topic specific education was used compared to a non-topic

specific education.[42] Also, no differences in physical therapist behavior were found when comparing a face-to-face course to an online course,[46] or dissemination of guidelines.[45] Physical therapist behavior changed more when an interactive workshop was used compared to a conventional education course.[44] There was no difference in behavior when subjects attended a joint specific course compared to course on a different joint region.[47]

[H1] Patient Outcomes

Nine papers analyzed patient outcomes[34,41,45,51-56] Six studies compared professional development to control[34,53-57] while 3 directly compared 2 educational interventions.[41,45,51] Meta-analyses and GRADE synthesis of these studies was not possible due to significant variability in how the education was delivered, the outcome measures used, and unclear baseline comparability due to the absence of baseline measures. Results from these studies are summarized in Table 2 and Table 4.

Of the 6 studies comparing learning activities to control, the learning objectives of the educational activities in 4 studies were related to the management of back pain,[34,53,54,57] one was persistent pain[56] and one was Parkinson's disease.[55] Of the studies comparing learning activities, 2 studies had learning objectives relating to neck pain disorders,[41,51] while the other related to whiplash.[45]

The only learning activity compared to control was courses.[34,53-57] Learning activities directly compared within trials were courses,[41,45,51] dissemination guidelines,[45] and outreach in the form of a mentored treatment session.[51]

Table 3 lists the different outcome measures used and the overall results for each study. Two different outcome measures were used to evaluate pain, 8 for disability and 2 for quality of

life. Five studies collected patient outcomes at 2 time points,[34,41,51,54,56] 1 at 4 time points,[55] 2 at 5 time points[53,57] and one at 6 time points.[45]

Risk of bias PEDro scores for studies comparing learning activities to control with patient outcomes, ranged from 4 to 6 with a median of 5. For studies comparing 2 different learning activities, PEDro scores ranged from 6 to 8, with a median score of 7 (Suppl. Appendix 4).

[H2] Impact on Pain

[H3] *Learning activity compared to control*

One study[34] found that a course improved the patient outcome of pain, whereas 5 studies found that completion of a course had no effect.[53-57]

[H3] *Comparing Learning activities*

The addition of a single follow up mentored treatment session to a face-to-face course was no more effective at improving the patient outcome of pain than a course alone.[51]

[H2] Impact on Disability

[H3] *Learning activity compared to control*

One study[34] reported an improvement in the outcome of disability when physical therapists participated in a course, whereas 5 studies found no difference when physical therapists attended a course.[53-57]

[H3] *Comparing Learning activities*

Studies comparing learning activities found a face-to-face whiplash course was no more effective at improving patient disability than dissemination of guidelines, and that the addition of a face-to-face follow up day to a neck pain course was not effective at further improving disability of the patients whose physical therapists attend these courses.[41,45] On the other hand, the addition of a follow up mentored treatment session to a face-to-face course was effective at improving the physical therapist's patient disability outcomes.[51]

[H2] Impact on Quality of Life

[H3] *Learning activity compared to control*

No differences in quality of life were found in 2 studies where physical therapists participated in courses.[53,55]

[H1] Discussion

This systematic review found that post-professional learning activities improved physical therapists' knowledge. However, these learning activities had inconsistent effects on changing affective attributes and clinical behavior (Tab. 2). Further, and perhaps more importantly, when patient outcomes were considered, physical therapy courses were not effective compared to no learning activity or the distribution of guidelines. However, the addition of an individualized, mentored patient interaction to a face-to-face course did improve disability for patients with neck pain.[51] While this evidence is limited to low level, the results provide valuable insights to inform the design of physical therapy CPD to enhance physical therapy expertise.

Development of expertise requires an environment where deliberate practice and feedback on performance can occur.[58] This type of learning environment may not available to health

professionals working as sole practitioners.[2,58] CPD opportunities have the potential to fill this gap, and should be guided by the master adaptive learner concept.[2,3] The master adaptive learner concept identifies 4 key phases for effective learning. These are the planning, learning, assessing and adjusting phases.[2] These phases require critical thinking and reflective practice with supportive scaffolding provided if required.[2]

This review found that activities with active learning components, such as feedback on performance, were more effective at enhancing practice, therefore supporting both the deliberate practice method for expertise development and the master adaptive learner concept. Hence CPD should provide a learning environment where expertise can be enhanced, rather than merely disseminating knowledge. The delivery methods of effective learning activities are the focus of the discussion in this review. Why these learning activities are effective, requires a deeper analysis and consideration of the perspective of the learner which is best evaluated through qualitative research. Consequently, why certain learning activities are perceived as effective by the learner is discussed the companion Qualitative (Part B) review where a thematic synthesis of qualitative studies has been completed.

Online, blended and face-to-face courses improved knowledge, supporting physical therapists' participation in these activities when the learning outcomes focus on knowledge gains. The fact that online courses support knowledge development is particularly important as online delivery has the potential to overcome the barriers of time, cost and geography reported by physical therapists.[59,60] However, care should be taken not to rely on the dissemination of information online, as dissemination alone was not as effective as a face-to-face course with interactive sessions and practicals.[45] Further, when online courses include active components such as feedback (delivered online), they can be equally effective as face-to-face courses at improving knowledge.[46] These results illustrate that online courses must include active components to enhance attainment of knowledge.

Similarly, face-to-face courses were more effective at improving knowledge, behavior and patient outcomes when they included active learning components, including patient interactive sessions, peer review or individualized mentored patient interactions. Patient interactive sessions required participant groups to interview a patient, collaborate on decisions and receive patient delivered feedback.[44] In peer assessment, structured, coach-facilitated environments were created where 2 participants role-played a case scenario with a third participant observing practice and providing feedback.[49,50] Individualized, mentored patient interaction involved an educator and participant assessing and managing a patient collaboratively in real time.[51] Each of these active learning activities provided a structured opportunity for learners to participate in a simulated or actual patient interaction, receive feedback and collaborate with others as required by the master adaptive learner phases of planning and assessment.[2] These active components align with constructivism and experiential learning theories, where learners learn best when they are motivated to actively and socially participate in learning, rather than passively observing or receiving content.[61] In addition, these activities are a form of retrieval practice that involves retrieval of information from memory, and has been found to enhance learning in other contexts involving simulation or health professional CPD.[62,63] As such, some form of retrieval practice should be considered when designing learning activities for physical therapists, and is recommended as part of the learning phase of the master adaptive learner concept.[2] Communities of practice such as those found in residency or fellowship programs,[64] can provide these active learning opportunities where retrieval practice, collaboration and feedback on performance may occur in a supportive and structured environment.

Structured opportunities for feedback and interaction appear important design features when the focus is on supporting clinical behavioral change. At face value, courses appeared to have inconsistent effects on behavior change (Tab. 2). However, on close inspection, there are

possible explanations for the effective courses compared to the ineffective ones. Two of the effective courses provided feedback to participants.[32,40] Conversely, the 2 ineffective courses did not report that feedback was provided to participants.[31,33] Feedback is a key aspect that enables the master adaptive learner planning and assessment phases, and has been identified as a key aspect in allied health clinical education requiring further research.[65] Furthermore an educational research systematic review of 65,000 studies[66] concluded that "structuring opportunities for students to then learn from each other, to practice over time, to receive feedback to correct errors and misconceptions, and to evaluate their learning are most valuable".[66] This recommendation appears as relevant for qualified physical therapists as it does for tertiary education students. Hence, the call for research into the impact of feedback during clinical learning should not be limited to entry-level education,[65] but should also explore the use of feedback for post-professional physical therapists.

A unique aspect of a course that changed behavior was the inclusion of a session consistent with the master adaptive learner adjustment phase where strategies are explored to implement new learning into routine clinical practice.[2] In this session, participants developed strategies collaboratively for overcoming barriers to their behavior change.[39] The possible effectiveness of this strategy is consistent with a recent knowledge translation scoping review, which recommended that assisting physical therapist learners to address barriers to behavior change should not be neglected when attempting to translate research into practice.[7] Although, again, the evidence is limited, and further research into this design feature is needed before best practice guidelines can be determined.

The variability observed in effectiveness of educational interventions so far has been explained by the learning activity variability, but there are also possible methodological explanations for the differences in the results. The use of psychometrically untested, bespoke outcome measures to evaluate change in knowledge, affective attributes and behaviors may

have influenced the outcomes observed. For example, blended courses consistently enhanced knowledge, but not behavior (Tab. 2). In the studies that assessed behavior change, all used self-reported bespoke measures that were not psychometrically tested. This inconsistent behavior change could therefore be due to these outcome measures lacking responsiveness to change. This limitation has been identified in medical education literature, and is not unique to the post-professional physical therapy learning research.[67] This significant challenge warrants the development of validated measures of learning for healthcare providers.

The variability of findings observed on patient outcomes could also be explained by the fact that many studies' aimed to evaluate the impact of a treatment approach, rather than physical therapists' learning.[53,55,56] That is, the effectiveness of the intervention taught to physical therapists had not been determined prior to the trial commencing. The apparent lack of an effect on patient outcomes may therefore be due to an ineffective treatment approach, rather than a lack of physical therapist learning. It is vital that future research controls this variable by ensuring that any educational intervention evaluated for impact on learning outcomes and physical therapy practice has an *a priori* established evidence base demonstrating an impact on patient outcomes.

While this systematic review presents the highest available quantitative evidence in the form of RCTs and used a comprehensive search, risk of bias assessment and synthesis of results based on the PRISMA guidelines, there are a few limitations. The broad research question resulted in the inclusion of studies that varied considerably in learning intentions (what taught), learning activities, and outcome measures used. This considerable variability meant that meta-analyses and a GRADE approach were rarely possible, and analyses were predominately descriptive in nature. Consequently, high-level evidence and recommendations were not forthcoming. Nonetheless, interpreting the results with consideration of other educational research and theory, provides insights on effective educational design features to

inform practice and guide future research. Further, learning is an individualized experience[66], and these experiences are needed to also be explored through qualitative research methods.[68] Hence, the quantitative results from Quantitative (Part A) review, should be interpreted alongside qualitative research, which has been appraised, synthesized and explored as a second component of this review (Part B).[13] A discussion and triangulation of the quantitative and qualitative findings is presented in the Qualitative (Part B) review and provides further guidance for current physical therapy CPD design and future research.

[H1] Conclusion

In conclusion, quantitative published evidence suggests that the knowledge, affective attributes and clinical behavior of physical therapists can be enhanced by learning activities. Patient outcomes were not enhanced by physical therapy courses; however, they may be improved with the uses of a mentored patient interaction. Unfortunately, the evidence is of low level with significant variability, and firm recommendations regarding the most effective learning activities are not yet possible. Further, due to the individualized experience of learning, the results from this review need to be triangulated with results from qualitative studies explored in a companion Qualitative (Part B) review. Resources should be directed towards providing robust research into this area, so that informed decisions can be made by organizations and individuals with regards to which professional development activities are worthy of participation. Active learning strategies appear to show the most promise and should be the target of future studies. In addition, future studies of physical therapist learning should directly compare different educational interventions in the same randomized controlled trial, ensure that the content taught has a strong evidence of improving patient outcomes and use psychometrically tested outcome measures.

Author Contributions and Acknowledgments:

Concept / idea / research design: E. Leahy, L. Chipchase, F.C. Blackstock

Writing: E. Leahy, L. Chipchase, F.C. Blackstock

Data collection: E. Leahy, M. Calo, F.C. Blackstock

Data analysis: E. Leahy, L. Chipchase, M. Calo, F.C. Blackstock

Project management: E. Leahy, F.C. Blackstock

Consultation (including review of manuscript before submitting): E. Leahy, M. Calo, F.C. Blackstock, L Chipchase

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Systematic Review Registration

This review is the first in a 2-part series based on a published protocol and was registered on the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42016050157).

Disclosures and Presentations

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

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References

1. Jensen GM, Gwyer J, Shepard KF. Expert practice in physical therapy. *Phys Ther.* 2000;80(1):28-43.
2. Cutrer WB, Miller B, Pusic MV, et al. Fostering the Development of Master Adaptive Learners: A Conceptual Model to Guide Skill Acquisition in Medical Education. *Acad Med.* 2017;92(1):70-75.
3. Cutrer WB, Atkinson HG, Friedman E, et al. Exploring the characteristics and context that allow Master Adaptive Learners to thrive. *Med Teach.* 2018;40(8):791-796.
4. Leahy E, Chipchase L, Blackstock F. Which learning activities enhance physiotherapy practice? A systematic review protocol of quantitative and qualitative studies. *Syst Rev.* 2017;6(1):83.
5. Ambrose SA, Bridges MW, DiPietro M, Lovett MC, Norman MK, Mayer RE. *How Learning Works : Seven Research-Based Principles for Smart Teaching.* Hoboken, UNITED STATES: John Wiley & Sons, Incorporated; 2010.
6. French H, Dowds J. An overview of continuing professional development in physiotherapy. *Physiotherapy.* 2008;94(3):190-197.
7. Stander J, Grimmer K, Brink Y. Training programmes to improve evidence uptake and utilisation by physiotherapists: a systematic scoping review. *BMC Med Educ.* 2018;18.
8. Forsetlund L, Bjorndal A, Rashidian A, et al. Continuing education meetings and workshops: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev.* 2009(2):Cd003030.
9. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev.* 2012;6:Cd000259.
10. Mansouri M, Lockyer J. A meta-analysis of continuing medical education effectiveness. *J Contin Educ Health Prof.* 2007;27(1):6-15.
11. O'Brien MA, Rogers S, Jamtvedt G, et al. Educational outreach visits: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev.* 2007(4):Cd000409.
12. Scott SD, Albrecht L, O'Leary K, et al. Systematic review of knowledge translation strategies in the allied health professions. *Implement Sci.* 2012;7:70.
13. Leahy E, Chipchase L, Calo M, Blackstock F. Which learning activities enhance physical therapy practice? Part B: Physical Therapist's Perspective. Systematic review and thematic synthesis. *Submitted for review.* 2019.
14. Altman DG, Bland JM. Statistics notes. Treatment allocation in controlled trials: why randomise? *Bmj.* 1999;318(7192):1209.
15. Burns PB, Rohrich RJ, Chung KC. The levels of evidence and their role in evidence-based medicine. *Plast Reconstr Surg.* 2011;128(1):305-310.

16. Koes BW, Hoving JL. The value of the randomized clinical trial in the field of physiotherapy *Man Ther.* 1998;3(4):179-186.
17. Fletcher RH, Fletcher SW, Fletcher GS. *Clinical Epidemiology- The Essentials.* 5th ed. Baltimore, Philadelphia: Williams & Wilkins; 2014.
18. de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Aust J Physiother.* 2009;55(2):129-133.
19. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther.* 2003;83(8):713-721.
20. Higgs J, Titchen A. The Nature, Generation and Verification of Knowledge,. *Physiotherapy.* 1995; 81(9):521-530.
21. Adams NE. Bloom's taxonomy of cognitive learning objectives. *J Med Libr Assoc.* 2015;103(3):152-153.
22. Grant AM, Franklin J, Langford P. The self-reflection and insight scale: a new measure of private self-consciousness. *Soc Behav Pers.* 2002;30:821-836.
23. Yost J, Ganann R, Thompson D, et al. The effectiveness of knowledge translation interventions for promoting evidence-informed decision-making among nurses in tertiary care: a systematic review and meta-analysis. *Implement Sci.* 2015;10:98.
24. Cohen J. *Statistical Power Analysis for the Behavioural Sciences.* 2nd ed. Hillside, NJ: Lawrence Erlbaum Associates; 1988.
25. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *Bmj.* 2003;327(7414):557-560.
26. Furlan AD, Pennick V, Bombardier C, van Tulder M. Updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine.* 2009;34(18):1929-1941.
27. Slater SL, Ford JJ, Richards MC, Taylor NF, Surkitt LD, Hahne AJ. The effectiveness of sub-group specific manual therapy for low back pain: a systematic review. *Man Ther.* 2012;17(3):201-212.
28. Maher CG. A systematic review of workplace interventions to prevent low back pain. *Aust J Physiother.* 2000;46(4):259-269.
29. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. Rating the quality of evidence--imprecision. *J Clin Epidemiol.* 2011;64(12):1283-1293.
30. Guyatt GH, Oxman AD, Montori V, et al. GRADE guidelines: 5. Rating the quality of evidence--publication bias. *J Clin Epidemiol.* 2011;64(12):1277-1282.
31. Almohiza M, Sparto P, Marchetti G, et al. A Quality Improvement Project in Balance and Vestibular Rehabilitation and Its Effect on Clinical Outcomes. *J Neurol Phys Ther.* 2017;40(2): 90-99.
32. Bekkering GE, Hendriks HJ, van Tulder MW, et al. Effect on the process of care of an active strategy to implement clinical guidelines on physiotherapy for low back pain: a cluster randomised controlled trial. *Qual Saf Health Care.* 2005;14(2):107-112.
33. Beissner KL, Bach E, Murtaugh CM, et al. Translating Evidence-Based Protocols Into the Home Healthcare Setting. *Home Healthc Now.* 2017;35(2):105-112.
34. Beneciuk JM, George SZ. Pragmatic Implementation of a Stratified Primary Care Model for Low Back Pain Management in Outpatient Physical Therapy Settings: Two-Phase, Sequential Preliminary Study. *Phys Ther.* 2015;95(8):1120-1134.
35. Dizon JM, Grimmer-Somers K, Kumar S. Effectiveness of the tailored Evidence Based Practice training program for Filipino physical therapists: a randomized controlled trial. *BMC Med Educ.* 2014;14:147.
36. Dizon JM, Grimmer-Sommers K, Kumar S. A Pilot Study of the Evidence Based Practice Training Program for Filipino Physiotherapists: Emerging Evidence on Outcomes and Acceptability. *Internet Journal of Allied Health Sciences & Practice.* 2012;10(2):6p-6p.

37. Fary RE, Slater H, Chua J, Ranelli S, Chan M, Briggs AM. Policy-into-practice for rheumatoid arthritis: randomized controlled trial and cohort study of e-learning targeting improved physiotherapy management. *Arthritis care & research.* 2015;67(7):913-922.
38. Moran M. Hypertext computer-assisted instruction for geriatric physical therapists. *Phys Occup Ther Geriatr.* 1991;10(2):31-53.
39. Murray A, Hall AM, Williams GC, et al. Effect of a self-determination theory-based communication skills training program on physiotherapists' psychological support for their patients with chronic low back pain: a randomized controlled trial. *Arch Phys Med Rehabil.* 2015;96(5):809-816.
40. Peter W, van der Wees PJ, Verhoef J, et al. Effectiveness of an interactive postgraduate educational intervention with patient participation on the adherence to a physiotherapy guideline for hip and knee osteoarthritis: a randomised controlled trial. 2015;37(3):274-282.
41. Chipchase LS, Cavaleri R, Jull G. Can a professional development workshop with follow-up alter practitioner behaviour and outcomes for neck pain patients? A randomised controlled trial. *Man Ther.* 2016;25:87-93.
42. Fruth S, Havertape L, Jones J, Newbury C, Conn L. Can onsite presentations led by physical therapist students increase clinicians' confidence in aspects of evidence-based practice? A pilot study. *J Phys Ther Educ.* 2013;27(3):49-62.
43. Van Peppen RP, Schuurmans MJ, Stutterheim EC, Lindeman E, Van Meeteren NL. Promoting the use of outcome measures by an educational programme for physiotherapists in stroke rehabilitation: a pilot randomized controlled trial. *Clin Rehabil.* 2009;23(11):1005-1017.
44. Peter WF, van der Wees PJ, Verhoef J, et al. Postgraduate education to increase adherence to a Dutch physiotherapy practice guideline for hip and knee OA: a randomized controlled trial. *Rheumatology.* 2013;52(2):368-375.
45. Rebbeck T, Maher C, Refshauge K. Evaluating two implementation strategies for whiplash guidelines in physiotherapy: a cluster randomised trial. *Aust J Physiother.* 2006;52(3):165-174.
46. Richmond H, Hall AM, Hansen Z, Williamson E, Davies D, Lamb SE. Using mixed methods evaluation to assess the feasibility of online clinical training in evidence based interventions: a case study of cognitive behavioural treatment for low back pain. *BMC Med Educ.* 2016;16:163.
47. Stevenson K, Lewis M, Hay E. Does physiotherapy management of low back pain change as a result of an evidence-based educational programme? *J Eval Clin Pract.* 2006;12(3):365-375.
48. Stevenson K, Lewis M, Hay E. Do physiotherapists' attitudes towards evidence-based practice change as a result of an evidence-based educational programme? *J Eval Clin Pract.* 2004;10(2):207-217.
49. van Dulmen SA, Maas M, Staal JB, et al. Effectiveness of peer assessment for implementing a Dutch physical therapy low back pain guideline: cluster randomized controlled trial. *Phys Ther.* 2014;94(10):1396-1409.
50. Maas MJ, van der Wees PJ, Braam C, et al. An innovative peer assessment approach to enhance guideline adherence in physical therapy: single-masked, cluster-randomized controlled trial. *Phys Ther.* 2015;95(4):600-612.
51. Cleland JA, Fritz JM, Brennan GP, Magel J. Does continuing education improve physical therapists' effectiveness in treating neck pain? A randomized clinical trial. *Phys Ther.* 2009;89(1):38-47.
52. Bekkering G, van TM, Hendriks E, et al. Implementation of clinical guidelines on physical therapy for patients with low back pain: randomized trial comparing patient outcomes after a standard and active implementation strategy. *Phys Ther.* 2005;85(6):544-555.
53. Lonsdale C, Hall AM, Murray A, et al. Communication Skills Training for Practitioners to. Increase Patient Adherence to Home-Based Rehabilitation for Chronic Low Back Pain:

Results of a Cluster Randomized Controlled Trial. *Arch Phys Med Rehabil.* 2017;98(9):1732-1743.
54. Overmeer T, Boersma K, Denison E, Linton S. Does teaching physical therapists to deliver a biopsychosocial treatment, program result in better patient outcomes? A randomized controlled trial. *Phys Ther.* 2011;91(5):804-819.
55. Munneke M, Nijkrake M, Keus S, et al. Efficacy of community-based physiotherapy networks for patients with Parkinson's disease: a cluster-randomised trial. *Lancet Neurol.* 2010;9(1):46-54.
56. Reid MC, Henderson CR, Trachtenberg MA, et al. Implementing a Pain Self-Management Protocol in Home Care: A Cluster-Randomized Pragmatic Trial. *J Am Geriatr Soc.* 2017;65(8):1667-1675.
57. Bekkering GE, van Tulder MW, Hendriks EJ, et al. Implementation of clinical guidelines on physical therapy for patients with low back pain: randomized trial comparing patient outcomes after a standard and active implementation strategy. *Phys Ther.* 2005;85(6):544-555.
58. Ericsson KA. Acquisition and maintenance of medical expertise: a perspective from the expert-performance approach with deliberate practice. *Acad Med.* 2015;90(11):1471-1486.
59. Bourne JA, Dziedzic K, Morris SJ, Jones PW, Sim J. Survey of the perceived professional, educational and personal needs of physiotherapists in primary care and community settings. *Health Soc Care Community.* 2007;15(3):231-237.
60. Chau J, Chadbourn P, Hamel R, et al. Continuing education for advanced manual and manipulative physiotherapists in Canada: a survey of perceived needs. *Physiother Can.* 2012;64(1):20-30.
61. Dennick R. Constructivism: reflections on twenty five years teaching the constructivist approach in medical education. *Int J Med Educ.* 2016;7:200-205.
62. Larsen DP, Butler AC, Lawson AL, Roediger HL, 3rd. The importance of seeing the patient: test-enhanced learning with standardized patients and written tests improves clinical application of knowledge. *Adv Health Sci Educ Theory Pract.* 2013;18(3):409-425.
63. Larsen DP, Butler AC, Aung WY, Corboy JR, Friedman DI, Sperling MR. The effects of test-enhanced learning on long-term retention in AAN annual meeting courses. *Neurology.* 2015;84(7):748-754.
64. Rodeghero J, Wang YC, Flynn T, Cleland JA, Wainner RS, Whitman JM. The impact of physical therapy residency or fellowship education on clinical outcomes for patients with musculoskeletal conditions. *J Orthop Sports Phys Ther.* 2015;45(2):86-96.
65. Johnson CE, Keating JL, Boud DJ, et al. Identifying educator behaviours for high quality verbal feedback in health professions education: literature review and expert refinement. *BMC Med Educ.* 2016;16:96.
66. Hattie J. The applicability of Visible Learning to higher education. *Scholarsh Teach Learn Psychol.* 2015;1(1):79-91.
67. Reed D, Price EG, Windish DM, et al. Challenges in systematic reviews of educational intervention studies. *Ann Intern Med.* 2005;142(12 Pt 2):1080-1089.
68. Tong A, Flemming K, McInnes E, Oliver S, Craig J. Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. *BMC Med Res Methodol.* 2012;12:181.

Table 1: Randomized Controlled Trial Study Characteristics

Authors, y	Location	Setting	Target Patient Group	Sample Size (Physical Therapists)	Sample Size (Patients)	Learning Activity Intervention
Almohiza et al,[31] 2017	USA	Rehabilitation Services	Balance/vestibular	19	454	Blended course, reminders
Beissner et al,[33] 2017	USA	Home healthcare agency	Pain	220	0	Blended course, reminders
Bekkering et al,[57] 2005a	Netherlands	Physical therapy practices	Low back pain	113	515	Course, reminders
Bekkering et al,[32] 2005b	Netherlands	Physical therapy practices	Low back pain	113	0	Course, reminders
Beneciuk and George,[34] 2015	USA	Outpatient physical therapy clinics	Low back pain	12	109	Course
Chipchase et al,[41] 2016	Australia	No specific	Neck pain	23	158	Course
Cleland et al,[51] 2009	USA	Private healthcare	Neck pain	19	939	Course, outreach mentoring
Dizon et al,[35] 2014	Philippines	Hospital Department	n/a	7	0	Blended course
Dizon et al,[36] 2012	Philippines	Not specific	n/a	52	0	Blended course
Fary et al,[37] 2015	Australia	Not specific	Rheumatoid arthritis	159	0	Online course
Fruth et al,[42] 2013	USA	Orthopedic outpatient clinics	n/a	52	0	Course (student led) Topic specific education General education

Lonsdale et al,[53] 2017	Ireland	Publicly funded outpatient clinics	Low back pain	255	50	Course, reminders
Maas et al,[50] 2015	Netherlands	Primary care in organized communities of practice	Upper extremity	149	0	Peer assessment Case discussion
Moran,[38] 1992	Not stated	Long term care facility	Wound	33	0	Online course
Munneke et al,[55] 2010	Netherlands	Community hospitals and catchment areas	Neurological	46[a]	699	Course
Murray et al,[39] 2015	Ireland	Hospital clinics	Low back pain	24	24	Course
Overmeer et al,[54] 2011	Sweden	Primary care	Musculoskeletal	42	266	Course
Peter et al,[40] 2015	Netherlands	Not specific	Osteoarthritis lower extremity	284	0	Interactive Course
Peter et al,[44] 2014	Netherlands	Not specific	Osteoarthritis lower extremity	203	0	Interactive Course Course
Rebbeck et al,[45] 2006	Australia	Physical therapy clinics	Neck pain	27	103	Course Guideline dissemination
Reid et al,[56] 2017	USA	Non-profit home health agency	Pain	Not reported	588	Course
Richmond et al,[46] 2016	England	National Health Service departments	Low back pain	35	0	Online course
Stevenson et al,[48] 2004	United Kingdom	Community Trust	Low back pain	30	0	Course
Stevenson et al,[47] 2006	United Kingdom	Community Trust	Low back pain	30	0	Course
van Dulmen et al,[49] 2014	Netherlands	Community of Practice	Low back pain	90	0	Peer assessment Case discussions

Van Peppen et al,[43] 2009	Netherlands	University	Neurological	30	0	Course with expert tutor Course with non-expert tutor

[a]Intervention group only. Control group sample size not reported.

Table 2: Summary of Results

Intervention	Comparison	Outcomes			
		Knowledge	**Affective**	**Behavior**	**Patient**
Blended course	Control	Effective (2)	No difference (1)	No difference (2)	
				Effective (1)	
Online course	Control	Effective (2)	Comparison favored (1)		
			No difference (1)		
Course	Control	Effective (1)	Effective (1)	Effective (2)	Effective (1)
			No difference (1)		No difference (5)
Interactive Course	Control	Effective (1)		Effective (1)	
Peer assessment	Case discussion	Effective(2)	Comparison favored (1)		
			No difference (1)		
Interactive Course	Course	No difference (1)		Effective (1)	
Course	Dissemination	Effective(1)		No difference (1)	No difference (1)
Online course	Course	No difference (1)		No difference (1)	
Course	In-service package on different area		No difference (1)	No difference (1)	
Course	Additional follow up day			No difference (1)	No difference (1)
Topic Specific Education	Education group			No difference (1)	
Course with expert tutor	Course with non-expert tutor			No difference (1)	
Course with outreach	Course				Effective (1)
					No difference(1)

Table 3: Therapist Outcome Results: Knowledge, Affective Attributes, and Behavior[a]

	Intervention	Comparison	Results		
			Favors Comparison	No difference	Favors Intervention
Outcome: Knowledge					
Dizon et al,[35] 2014	Blended course	Control			Evidence-based practice: Adapted Frensco Test
Dizon et al,[36] 2012	Blended course	Control			Evidence-based practice: Adapted Frensco Test
Fary et al,[37] 2015	Online course	Control			Rheumatoid arthritis clinical statements agreement[a] Rheumatoid arthritis vignette: ACREU primary care survey
Moran,[38] 1992	Online course	Control			Wound care knowledge survey
Peter et al,[40] 2015	Interactive Course	Control			Osteoarthritis hip and knee guideline knowledge questionnaire
Maas et al,[50] 2015	Peer assessment	Case discussion			Osteoarthritis vignettes
Peter et al (2013)[44]	Interactive course	Course		Osteoarthritis hip and knee guideline knowledge questionnaire	
Rebbeck et al,[45] 2006	Course	Guideline dissemination			Whiplash guidelines knowledge questionnaire
Richmond et al,[46] 2016	Online course	Course		Cognitive Behavioral Approach theoretical and procedural knowledge questionnaire	
van Dulmen et al,[49] 2014	Peer Assessment	Case discussion			Back pain vignettes
Outcome: Affective Attributes					
Beneciuk and	Course	Control		HC-PAIRs	PABS-PT(biomedical)

	Intervention	Comparison	Results		
			Favors Comparison	No difference	Favors Intervention
George,[34] 2015					PABS-PT (biopsychosocial)
Dizon et al,[35] 2014	Blended course	Control		Evidence-based practice attitudes questionnaire[b]	
Maas et al,[50] 2015	Peer Assessment	Case discussion	Reflective practice: Self-Reflection and Insight Scale		
Richmond et al,[46] 2016	Online course	Course	PABS-PT (biomedical)	PABS-PT (psychosocial)	
Stevenson et al,[48] 2004	Course	Inservice package on different joint area		Evidence-based practice attitudes questionnaire	
van Dulmen et al,[49] 2014	Peer Assessment	Case discussion		Reflective practice: Self-Reflection and Insight Scale	
Outcome: Behavior					
Almohiza et al,[31] 2017	Blended course, reminders	Control		Adherence to clinical treatment algorithm (self-reported)	
Beissner et al,[33] 2017	Blended course	Control		Documentation of learned treatment (self-reported)[b]	
Bekkering et al,[32] 2005b	Course, reminders	Control			Adherence to guidelines (self-reported)[c]
Dizon et al,[35] 2014	Blended course	Control			Evidence-based behaviors documented in diary
Murray et al,[39] 2015	Course	Control			Health Care Climate Questionnaire rating of patient/therapist audio recording
Peter et al,[40] 2015	Interactive course	Control			Adherence (self-reported questionnaire) Quality Indicators for Physiotherapy Care in Hip and Knee Osteoarthritis

	Intervention	Comparison	Results		
			Favors Comparison	No difference	Favors Intervention
Chipchase et al,[41] 2016	Course	Additional follow up course day		Frequency of neck pain specific management technique use (self-reported)	
Peter et al,[44] 2013	Interactive course	Course			Adherence (self-reported questionnaire) Quality Indicators for Physiotherapy Care in Hip and Knee Osteoarthritis
Fruth et al,[42] 2013	Topic Specific Education	Education group		Evidence-Based Practice behavior (self-reported)[d]	
Rebbeck et al,[45] 2006	Course	Guidelines Dissemination		Whiplash guideline adherence (self-reported and audit)[b]	
Richmond et al,[46] 2016	Online course	Course		Cognitive Therapy Scale-Revised Pain rating of an audio recording of the patient/therapist interaction	
Stevenson et al,[47] 2006	Course	Inservice package on different joint area		Treatment approaches most commonly used in patient care (self-reported discharge report)[c]	
Van Peppen et al,[43] 2009	Course with expert tutor	Course with non-expert tutor		Use of outcome measures (audit)	

[a]HC-PAIRs = Health Care Providers Pain and Impairment Relationship Scale; PABS-PT = Pain attitudes and Beliefs Scale for Physiotherapists

[b]If outcome involved more than 3 parts, and then outcome was determined to be that with the most. For Beissner (2017) behavior outcome, 6 of the 7 documented behaviors found no difference. For Dizon (2014) attitudes outcome, 5 of the 7 attitude statements found no difference. For Fary (2015) knowledge outcome with clinical statement agreement, 4 out of the 6 outcome statements favored intervention. For Rebbeck (2006), 3 out of the 5 documented behaviors found no difference).

[c]No p value reported. (For Bekkering (2005b) behavior outcome, odds ratios used)

[d]This study had between group differences at post-intervention time point, however no within group differences (ie, no statistically significant improvement in the Topic specific group over time). Amended – this study had 2 out of 4 questions (outcome measures) finding between group differences at 1 month post. At 6 months post, there were no between group differences for any of the 4 questions (outcome measures).

Table 4: Patient Outcome Results. Pain, Quality of Life, Disability

Study	Intervention	Comparison	Results		
			Favors Comparison	No difference	Favors Intervention
Bekkering et al,[57] 2005a	Course, reminders	Control		Pain (Numeric Pain Rating Scale) Disability (Quebec Back Pain Disability Scale)	
Beneciuk and George,[34] 2015	Course	Control			Pain (Numeric Pain Rating Scale) Disability (Oswestry Disability Index)
Lonsdale et al,[53] 2017	Course	Control		Pain (Numeric Pain Rating Scale) Disability (Roland-Morris Disability Questionnaire, Patient Specific Functional Scale) Quality of Life (European Quality of Life Questionnaire)	
Munneke et al,[55] 2010	Course	Control		Disability (Patient Specific Index for Parkinson's Disease)[a] Quality of Life (Modified Parkinson Activity Scale)[a]	
Overmeer et al,[54] 2011	Course	Control		Pain (Likert scale from Orebro 0 - 10) Disability (Quebec Back Pain Disability Scale)	
Reid et al,[56] 2017	Course	Control		Pain (Numeric Pain Rating Scale) Disability (Roland-Morris Disability Questionnaire)	
Chipchase et al,[41] 2016	Course, with follow up day	Course no follow up day		Disability (Neck Disability Index)	
Cleland et al,[51] 2009	Course, with outreach	Course alone		Pain (Numeric Pain Rating Scale)	Disability (Neck Disability Index)
Rebbeck et al, 2006[45]	Course	Guidelines Dissemination		Disability (Functional rating index, Core Outcome Measure)	

[a]p value not reported

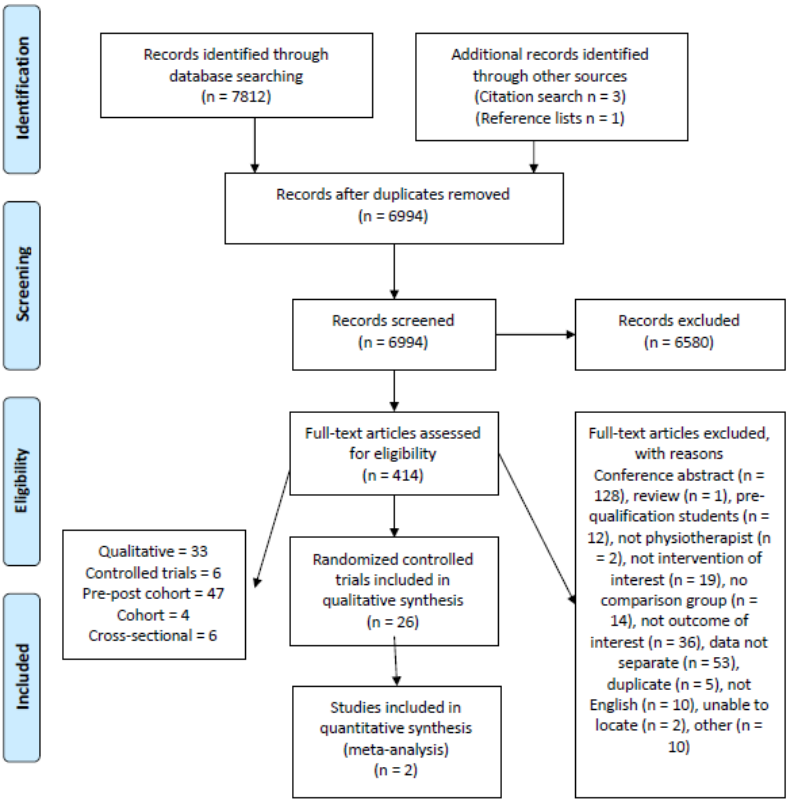

Figure: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart.