

# Evidence-based practice in physiotherapy education

Challenges for integration in clinical education

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## **Scientific environment**

The scientific environment for this doctoral thesis was the Centre of Evidence-Based Practice, Faculty of Health and Social Sciences, Bergen University College led by Professor Monica Wammen Nortvedt.

The studies undertaken for this dissertation was carried out under the main supervision of Professor Jan Magnus Bjordal, Professor at the Physiotherapy Research Group, Department of Global Public Health and Primary Care, University of Bergen, Norway. Bjordal also has a part time position at the Centre of Evidence-Based Practice, Faculty of Health and Social Sciences, Bergen University College, where he is the head of the research group NorPhyPain.

Co-supervisors were Professor Peter Bradley, Health Director, Public Health Wales, Cardiff, UK; Professor Monica Wammen Nortvedt, Head of Centre of Evidence-Based Practice and Vice Dean at Faculty of Health and Social Sciences, Bergen University College, Norway; and, Professor Birgitte Espehaug, Centre of Evidence-Based Practice, Faculty of Health and Social Sciences, Bergen University College, Norway.

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## **Foreword**

Evidence-based practice has been part of my professional integrity since I graduated from Coventry University College in the UK, in 1998. As a student I learned to use research evidence in both academic and clinical settings. This interest in using research evidence in physiotherapy was the reason I started my Master's. My Master thesis (2006), led me to my current teaching position at Bergen University College. In this position I have been given opportunities to develop my knowledge and skills in teaching evidence-based practice. Many thanks to the Centre of Evidence-Based Practice for providing courses in teaching evidence-based practice and a social milieu that facilitated evidence-based practice in both clinical practice and higher education.

# Abstract

**Background and aim:** Physiotherapists are expected to practice evidence-based. Evidence-based practice (EBP) should be integrated into undergraduate education to ensure that future graduates have the necessary EBP knowledge, skills and attitudes. Results from previous research show that students struggle to apply EBP in real patient situations. Efforts are needed to ensure that EBP is integrated into clinical physiotherapy education. The overall aim of this study was to contribute to knowledge and understanding of how to ensure use of EBP in clinical physiotherapy education.

**Methods:** Three studies with different design were conducted. *Paper I:* In this cross-sectional study, five cohorts (2006-2010) with final year physiotherapy students participated. In total, 246 students were eligible for this study. We used a 42-item questionnaire with items related to EBP behaviour, ability and barriers, and investigated associations using Spearman's rho ( $r$ ). *Paper II:* In this interpretive descriptive study six focus group interviews were conducted to explore beliefs, experiences and attitudes related to third year students' use of EBP in clinical physiotherapy education among students ( $n=16$ ), clinical instructors (CIs) ( $n = 9$ ) and visiting teachers ( $n = 4$ ). *Paper III:* In this non-randomized controlled study the short and long term impact of a six-month multifaceted and clinically integrated training program in EBP was evaluated among CIs in physiotherapy on EBP knowledge, skills, beliefs and behaviour. We invited 37 CIs to participate. Three self-administered questionnaires were administered pre- and post-intervention, and at six-month follow-up (The Adapted Fresno Test (AFT), the EBP Belief Scale and the EBP Implementation Scale).

**Results:** *Paper I:* We achieved a response rate of 73 %. The association between the level of EBP exposure and students' self-reported EBP behaviour, abilities and barriers was low for most items in the questionnaire. The strongest correlation was found between the level of EBP exposure and ability to critically appraise research evidence ( $r = 0.41$ ,  $p < 0.001$ ), and to what extent the participants perceived critical appraisal skills as a barrier ( $r = -0.31$ ,  $p < 0.001$ ). A statistically significant association related to



students' use of research evidence in real clinical situations was not found. *Paper II:* Four integrative themes emerged from the constant comparative analysis: 1) attempt to apply EBP, 2) novices in clinical practice, 3) prioritize practice experience over EBP and 4) lack role models in EBP. Students tried to search for research evidence and to apply this knowledge during clinical placements. As novices they needed more background knowledge than research evidence, tended to lean on their CIs, and were more eager to gain practical experience than practicing evidence-based physiotherapy. Students and CIs perceived a lack of role models in EBP. *Paper III:* In total, 29 CIs agreed to participate in the study (Intervention group: n = 14, control group: n = 15). One in the intervention group and five in the control group were lost to follow-up. At follow-up, the group difference was statistically significant for two of the outcome measures: the AFT (mean difference = 37, 95% CI (15.9 - 58.1),  $p < 0.001$ ) and the EBP Beliefs scale (mean difference = 8.1, 95% CI (3.1 - 13.2),  $p = 0.002$ ), but not for the EBP Implementation scale (mean difference = 1.8, 95% CI (-4.5 - 8.1),  $p = 0.574$ ). Comparing measurements over time, we found a statistically significant increase in mean scores related to all outcome measures for the intervention group only.

**Conclusions:** With increasing exposure to EBP students more frequently critically appraised research evidence (Paper I). A similar association was not found with regard to use of research evidence in real clinical situations (Paper I). Interviews with students, CIs and visiting teachers revealed that students at clinical placement attempted EBP, but as novices they struggled, leaned on their CIs, prioritized practice experience over EBP and lacked role models in EBP (Paper II). As CIs are in a unique position to influence students during clinical education we conducted a multifaceted and clinically integrated training program in EBP among CIs (Paper III). This training program was successful in improving EBP knowledge, skills and beliefs among CIs. Future studies are needed to ensure long-term EBP behaviour change among CIs. Unanswered questions are related to the impact of a training program in EBP on CIs' abilities to apply EBP knowledge and skills when supervising students, and whether improved EBP competence among CIs will have an impact on students' EBP behaviour. Further research is also needed to explore strategies for EBP exposure throughout the curriculum, regarding content, timing, amount and type of training.

## List of publications

- Paper I** Olsen, N. R., Lygren, H., Espehaug, B., Nortvedt, M. W., Bradley, P., & Bjordal, J. M. (2014). **Evidence-based Practice Exposure and Physiotherapy Students' Behaviour during Clinical Placements: A Survey.** *Physiotherapy Research International*. doi: 10.1002/pri.1590.
- Paper II** Olsen, N. R., Bradley, P., Lomborg, K., & Nortvedt, M. W. (2013). **Evidence based practice in clinical physiotherapy education: a qualitative interpretive description.** *BMC Medical Education*, 13(1), 52. doi: 10.1186/1472-6920-13-52.
- Paper III** Olsen, N. R., Bradley, P., Espehaug, B., Lygren, H., Frisk, B., Nortvedt, M. W., & Bjordal, J. M. (2014). **Impact of a Multifaceted and Clinically Integrated Training Program in Evidence-Based Practice on Knowledge, Skills, Beliefs and Behaviour among Clinical Instructors in Physiotherapy: A Non-Randomized Controlled Study.** *PLoS One*. 2015;10:e0124332.

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## Abbreviations

AFT	Adapted Fresno Test
BEME	Best Evidence Medical Education
BUC	Bergen University College
CI	Confidence Interval
CI/CIs	Clinical instructor(s)
COP	Communities of Practice
EBHC	Evidence-based Health Care
EBM	Evidence-based Medicine
EBP	Evidence-based Practice
GEE	Generalized Estimating Equations
ICC	Intraclass Correlation Coefficients
KACE	The Knowledge, Attitudes, Access and Confidence Evaluation
NNT	Number Needed to Treat
NSD	Norwegian Social Science Data Services
MD	Mean Difference
PBL	Problem Based Learning
RCT	Randomized Controlled Trial
SDM	Shared Decision Making
SU	Stellenbosch University
WCPT	World Confederation of Physical Therapy
WHO	World Health Organization

# 1. Background

Science has resulted in major advances in the treatment, prevention and diagnosis of diseases, but a persistent gap still exists between existing knowledge and what is actually being done [1, 2]. Today's health care recipients are suffering from unnecessary tests and procedures, and prevention opportunities are missed [3]. There is a need for improving the quality of health care, including physiotherapy.

Physiotherapists do not always provide evidence-based treatments. Results from several studies among physiotherapists show possible *underutilization* of effective treatments (e.g. therapeutic exercises) [4-7], and *overutilization* or *misuse* of treatment modalities not supported by research evidence (e.g. massage) [8]. Actions are needed for bridging the gaps between what physiotherapist do and existing knowledge from research evidence.

Evidence-based practice (EBP) is an approach to ensure that health care decisions are informed by the best available, current, valid and relevant research evidence [9]. EBP is regarded as one of several core competences in health professional education by the Institute of Medicine [10]. It is recommended that health care professionals integrate the necessary knowledge, skills and attitudes of EBP into their undergraduate education [9]. Future health care graduates should learn how to integrate EBP skills with their own life-long learning and patient care. Teaching EBP has become part of the standard curriculum for health care students in many countries, and across several professions [11-17]. EBP should be integrated throughout the curriculum [18, 19], and into clinical education [12, 15, 16]. The World Confederation of Physical Therapy (WCPT) [20] recommends that physiotherapy curriculum should prepare students to practice evidence-based. In Norway, EBP in health care and health care education has been supported and encouraged in white papers and health care strategies [21-23]. A new health and care strategy [24] was recently released and it focuses on EBP as a means to high quality care, patient safety and efficiency. In line with previous international and national recommendations, this new strategy [24] stresses the importance of mandatory teaching in EBP in all health care education in Norway.

## 1.1 What is evidence-based practice?

EBP is an approach to clinical decision making for health care professionals. A variety of definitions of EBP have been suggested. Within physiotherapy, the WCPT [25] refers to the following definition:

EBP is an approach to health care wherein health professionals use the best available evidence from systematic research, integrating it with clinical expertise to make clinical decisions for individual patients. EBP values, enhances and builds on clinical expertise, knowledge of disease mechanisms, and pathophysiology. It involves complex and conscientious decision-making based not only on the available evidence but also on patient characteristics, situations, and preferences. It recognises that health care is individualised and ever changing and involves uncertainties and probabilities.

Essential to EBP is the integration of the best available evidence from systematic research with our clinical expertise and our patients' preferences [26]. These elements of EBP will be further explained.

### *Best available evidence from systematic research*

Sackett et al. [27] stated that systematic research from the best available external clinical evidence refers to clinically relevant research. Clinical research refers primarily to research on patients conducted in clinical settings [28]. This type of research is more often applied research, designed to find a solution to a practical problem, as opposed to basic research, designed to extend the base of knowledge for the sake of knowledge or theory production itself [29, p. 747-748]. Clinically relevant research can come from the basic sciences, such as genetics or immunology [30]. However, more often this type of research comes from patient centred clinical research that answers questions about: the accuracy of diagnostic tests, the course of a condition (prognosis), and the efficacy, effect and safety of therapeutic, rehabilitative and preventive interventions [28, 30]. Recent textbooks on EBP emphasize that important clinical research can also come from qualitative research that examines questions about patients' expectations and experiences of illness [28, p. 13 and 16]. Focus on

qualitative research is in line with a call for a broader research agenda [31] that embraces “the experience of illness, the negotiation of sharing of evidence by clinicians and patients, and how to prevent harm from overdiagnosis”.

### *Clinical expertise*

Clinical expertise involves the ability to use both clinical skills and past experience “...to rapidly identify each patient’s unique health state and diagnosis, their individual risks and benefits of potential interventions, and their personal circumstances and expectations” [26, p.1]. Neither clinical expertise nor research evidence alone is enough as even excellent external research evidence “...may be inapplicable to or inappropriate for an individual patient” [30]. Clinical expertise must be used to balance and integrate relevant research evidence and patients’ circumstances and preferences and situation before making decisions [32, 33].

Expertise should be viewed as a continuum, allowing for a developmental process that progresses through training, experience and practice, often within a specific field [34, p. 59, 65-66]. Consequently, expertise is not a state to be achieved, but a process that develops “...when the clinician tests and refines propositions, hypotheses and principle-based expectations in actual practice situations” [35, p.3]. Expertise is “...a goal, a journey rather than arrival”, with the need for continual growth and development [34, p.67]. There is a general consensus that it takes time and practice to gain a certain level of skills and experience [35-38]. Thus, it is not surprising that there will be differences between a beginner or a novice and an expert and in the field [35, 37].

Expertise can also be said to encompass somewhat more than experience and skills, as expertise is a phenomenon that has multiple interpretations and dimensions depending on context and time [34, p. 66]. These dimensions could include clinical outcomes, professional judgement, clinical reasoning, technical clinical skills, communication, and interpersonal skills, a sound knowledge base, and cognitive and metacognitive proficiency. In particular, clinical reasoning and professional judgment are critical components of clinical expertise [39, p. 10, 40].



The term clinical reasoning has traditionally been referred to as “...the thinking and associated decision making of the clinician in practice” [41, p.184]. This term has expanded to also involve the patient and “...occurring during the initial diagnostic encounter, and evolving throughout the subsequent interaction and management over the entire course of a patient care” [41, p.184]. This is in line with Higgs’ and Jones’ [39, p.11] definition of clinical reasoning:

...a process in which the clinician, interacting with significant others (client, caregiver, health care team members), structures meaning, goals and health management strategies based on clinical data, client choices, and professional judgment and knowledge.

Clinical reasoning skills are essential for EBP [39, p.313, 42, 43, p.193, 44, p. 193-194]. Clinical reasoning can be viewed as a vehicle for interpreting and making knowledge (research evidence) relevant to real and specific patient situations [44, p. 191, 194].

Clinical judgment is a term that describes how health professionals attend and respond, based on how they come to understand problems, issues, or concerns of patient [36, p.200]. Clinical judgement involves blending skills and experience to make good clinical decisions in an appropriate way [45, p.2].

### ***Patient preferences***

Health professionals’ awareness of patients’ experiences and perspectives is essential for successful application of EBP [46, p. 207]. EBP is an approach that promotes the importance of incorporating patients’ preferences in the decision-making process [25]. Health professionals must integrate patients’ values; their unique preferences, concerns and expectations into clinical-decision making [26, p.1]. This is in line with another decision-making process called “shared decision making” (SDM) [47]. The Informed Medical Decision Foundation [48] define SDM as: «...a collaborative process that allows patients and their providers to make health care decisions together, taking into account the best scientific evidence available, as well as the patient’s values and

preferences”. SDM involves discussing the options and the benefits and harms, and having considered the patient’s values, preferences and circumstances [49]. One of several questions health professionals must ask is “Does the patient have enough information to make a choice?” [50]. The process of SDM involves bringing research evidence into the discussion with the patient, and as such, can be considered a way of incorporating research evidence into clinical practice.

## 1.2 Evidence-based practice processes

To really understand what EBP is it is necessary to differentiate between evidence-based *processes* and evidence-based *outcome* [9]. EBP involves the process of following the “5-step EBP model”: 1) translation of uncertainty to an answerable question, 2) systematic retrieval of best evidence available, 3) critical appraisal of evidence for validity, clinical relevance, and applicability, 4) application of results in practice and 5) evaluation of performance [9]. Each of the steps again requires following several specific EBP *processes* (Table 1). EBP *outcome* refers to the end point of following these processes.

**Table 1.** The EBP steps and processes

Steps		Processes
Step 1	ASK	<ul style="list-style-type: none"> <li>Recognize knowledge-gaps and information need</li> <li>Translate the information need into answerable and focused clinical questions (therapy/prevention, prevalence, diagnosis, prognosis, causation, experience)</li> </ul>
Step 2	SEARCH	<ul style="list-style-type: none"> <li>Recognize what type of information is needed</li> <li>Identify relevant evidence sources</li> <li>Design a systematic and comprehensive search strategy</li> <li>Systematically search for the best research evidence with which to answer the clinical question</li> </ul>
Step 3	APPRAISE	<ul style="list-style-type: none"> <li>Critically appraise that research evidence for its validity, impact and clinical applicability and importance</li> </ul>
Step 4	INTEGRATE	<ul style="list-style-type: none"> <li>Integrate and apply results from research evidence to the patient situation</li> <li>Take into account clinical expertise, patients’ characteristics, values, situation and preferences</li> </ul>
Step 5	EVALUATE	<ul style="list-style-type: none"> <li>Evaluate the effectiveness and efficiency the processes of step 1-4</li> <li>Seek ways to improve the process for next time</li> </ul>

Table 1. is inspired by several central previous EBP publications [9, 26, 51, 52] (Refined version of Table 2, Paper I).

Each of the steps requires different forms of competencies or skills. First and foremost, for questions to be initiated (Step 1), health professionals need to have both the

attitudes and skills to reason about uncertainties. Some authors [9] describe this process as “step-0”. In addition, literature searching skills are needed for Step 2 (search), and mastery of epidemiology and biostatistics is needed for step 3 (appraise) [53]. Following all steps for each clinical situation is regarded as “full-blown practice” of EBP [26, p.3]. This process is time consuming, and is not regarded as a prerequisite for EBP. Ability to master the different EBP skills can be dependent on factors such as prior exposure to EBP, the level of responsibility, level of expertise, organizational barriers and personal beliefs [9, 54, 55]. Broadly speaking, using evidence-based processes can be done in three different ways or modes: 1) as a doer, 2) as a user or 3) as a replicator [26, p. 4, 54]. The “doing” mode involves following at least the first four steps; the “using” mode involves following all steps except for step 3 (critical appraisal) and searches are restricted to evidence summaries (pre-appraised evidence sources); and, the “replicating” mode involves following decisions of respected opinion leaders and questioning if decisions really are evidence-based.

For many reasons it is unrealistic to expect every clinician or student to follow all steps (“doing-mode”) for all clinical questions, as time, indisputably, is a real constraint in many clinical settings. Busy clinicians are more likely to practice the “using” mode. As a response, pre-searched and pre-appraised evidence-sources have been developed (e.g. Clinical Evidence, Cochrane Library) [56, 57]. The “6S” model (previously described as 4S and 5S model) is developed to guide clinicians and decision makers (whatever mode) to begin the search for relevant and high quality research evidence at the highest possible level of the pyramid [56, 57]. This model is illustrated as a pyramid with 6 levels: 1) *Systems* (computerized decision support through patient journals), 2) *Summaries* (clinical pathways or textbook summaries about specific problems, e.g. Clinical evidence, Dynamed, Pier, UpToDate, or clinical practice guidelines), 3) *Synopsis of syntheses* (evidence-based journals/abstracts), 4) *Syntheses* (systematic reviews), 5) *Synopsis* of single studies (e.g. Evidence-Based Nursing), and at the bottom of the pyramid; 6) *Studies* (original articles) [56]. This model aims to aid clinicians to quickly find relevant research evidence of high quality- Clinicians are advised to start with evidence from the highest level from *systems* (if they exist) and continue to the next best level *summaries* where evidence from

primarily systematic reviews are integrated; these summaries provide a full range of evidence related to management (examination/ diagnoses and treatment) for particular health problems. This principle is further facilitated by an evidence-based medicine (EBM) information delivery service on the web called McMaster PLUS [58].

### 1.3 Evidence-based practice in curricula

Curricula for health care professions should be designed to deliver the necessary competencies to ensure that students graduating have the appropriate knowledge and skills to practice all five steps and the underlying processes (Table 2) [9]. Teaching and learning of EBP should be integrated into the clinical setting to ensure that students know how to apply these skills when they face real patient care, and situations where “full-blown” EBP is required (“doing-mode”). The importance of requiring skills in all steps among undergraduate curricula is emphasised in various educational policy documents for health care professionals [59, 60]. Skills to find relevant research evidence quickly, and to critically appraise and apply this evidence to patient care, are regarded as essential as other clinical skills, such as using a stethoscope [61]. These basic skills should be taught early, integrated across all years of the curriculum and into the professional examination to ensure the uptake of these skills [61]. These actions will “future proof” health care graduates by ensuring life-long learning and the ability to adapt to changing circumstances throughout the professional life [9].

The 5-step model of EBP has been used in medical teaching since the 1980s until today [9, 62-67]. This clinical learning strategy was first introduced at McMaster University in Canada, under the label of EBM and in the context of medical practice and teaching [63, 65, 66]. In the beginning, teachers from McMaster University offered short courses to clinicians focusing on critical appraisal of articles on diagnosis or therapy, and soon, accompanied by the publication of several textbooks and online supportive materials, such workshops were offered around the world [9]. EBM was also used within a problem-based learning (PBL) strategy that was initiated at McMaster University School of Medicine [62]. These medical teachers used an active, problem-based self-directed learning, and were pioneers in investigating the impact of

teaching EBM [65, 68]. EBM as a learning strategy is no less relevant today, and in line with new trends in education, for example as advocated in the Lancet commission report: Education of health professionals for the 21<sup>st</sup> century [69]. This report highlights different shifts in education, and one essential shift involves a change “...from fact memorisation to critical reasoning that can guide the capacity to search, analyse, assess, and synthesise information for decision making” [69], which are all essential skills needed to practice the 5-step model in EBP.

EBM is an educational movement that has been dedicated to “...clarifying, codifying and disseminating principles of methodological evaluation of research” and increasing “...research literacy on the part of educators and clinical learners” [70]. This movement developed from focusing on clinical epidemiology and critical appraisal to explicit decision making in daily practice[9]. At an early stage of this movement, “medicine” in EBM was replaced by “practice” and the term EBP was “born” [71, 72]. Evidence-based health care (EBHC) is also an alternative term to EBM [9, 71]. EBHC refers to decision making that affects the care of populations and individual patients, whereas EBP primarily refer to the interaction between the health practitioner and the individual patient [71]. I will continue to refer to EBP in this text.

## 1.4 Evidence-based practice outcomes

Multiple dimensions or educational outcomes, such as knowledge, skills, attitudes, behaviours and clinical outcomes, have been described as relevant outcomes for assessing EBP learning [54, 73]. Some authors [74, 75] argue that researchers should look to recommendations for outcome assessment from networks such as Best Evidence Medical Education (BEME) [76], or use objective scales or taxonomies such as Bloom’s taxonomy [77, 78] or Kirkpatrick’s levels [79]. Kirkpatrick’s levels are typically outcomes used to evaluate medical education [80, 81]. Shaneyfelt et al. [82] were unaware of any such taxonomy, when they [73] described the typical EBP outcomes: knowledge, skills, attitudes, behaviours and clinical outcomes.

Nevertheless, the similarities are striking when comparing the outcomes described by Shaneyfelt et al. [73] to the Kirkpatrick’s levels (Table 2). Shaneyfelt et al. [73] do not

describe the Kirkpatrick's level "Reaction to the educational experience", but they do take into account attitudes, which are evident in later modified versions of the Kirkpatrick's levels [80, 81].

After the systematic review by Shaneyfelt et al. [73], Tilson et al. [55] presented another model for the assessment of EBP educational interventions that was inspired by the model by Freeth et al. [81]. Freeth et al. [81] presented a modified version of Kirkpatrick's model that was informed by the evaluations in their critical review of evaluations of interprofessional education. These evaluations resulted in the authors adding two further levels to the original Kirkpatrick's model. Freeth et al. [81] specified that the outcomes in the different areas were not hierarchical. The aim of the model was to encourage more holistic and comprehensive evaluations for future policy and development. For each level in the model, it becomes progressively more difficult to gather trustworthy data. However, Yardley and Dornan [80] disagree and regard the different Kirkpatrick levels as hierarchical, considering the higher Kirkpatrick level as greater quality. Referring to Kirkpatrick's levels as a hierarchy, does make sense when considering that the ultimate aim of EBP teaching intervention is to affect patient care, either at the individual patient or organizational level. Yardley and Dornan [80] suggest using the Kirkpatrick's levels as presented in the BEME Collaboration's coding sheet as a grading standard for bibliographic reviews of medical education. The similarities are striking also when comparing the initially suggested EBP outcomes by Shaneyfelt et al. to the model by Freeth et al., the Kirkpatrick levels in the BEME collaboration coding sheet and the model presented by Tilson et al. (Table 2).

**Table 2.** EBP outcomes by Shaneyfelt et al. compared to other Kirkpatrick models

Shaneyfelt et al. [73]	Kirkpatrick's levels [73]	Freeth et al. [81]	BEME* [76, 80]	Tilson et al. [55]
	Reaction (to educational experience)	Reaction (learners views on learning experience)	Participation (learners views on learning reaction)	Reaction to the EBP educational experience
<b>Attitudes</b> (towards EBP)		Modification of attitudes/ perceptions	Modification of attitudes/ perceptions	Attitudes about EBP
				Self-efficacy for conducting EBP
<b>Knowledge</b> (about EBP)	Learning (the acquisition of skills and knowledge)	Acquisition of knowledge/ skills	Modification of knowledge/ skills	Knowledge about EBP principles
<b>Skills</b> (applying knowledge/ performing EBP steps)				Skills for performing EBP
<b>Behaviour</b> (enacting EBP steps in patient care activities/ evidence based manoeuvres (actions))	Behaviour change (participants do things differently/application to practice)	Behavioural change (transfer of learning to practice settings/ changed professional practice)	Behavioural change (transfer of learning to the workplace, willingness to apply knowledge/skills)	Behaviour congruent with EBP as part of patient care
<b>Behaviour cont.</b> (affecting patient outcomes)	Results (in relation to intended outcomes)	<ul style="list-style-type: none"> <li>• Change in organisational practice</li> <li>• Benefits to patients/ clients</li> </ul>	<ul style="list-style-type: none"> <li>• Change in organisational practice</li> <li>• Benefits to patient/ clients</li> </ul>	Benefit to patients associated with EBP

\*BEME = Best Evidence Medical Education

Kirkpatrick's model has been criticized for not allowing "...for the rich variety of outcomes that can be evaluated using qualitative as well as quantitative methodologies...", nor does it "...explain how or why such outcomes are consequential to particular elements of complex interventions" [80]. Yardley and Dornan [80] state that this model is used to focus on measuring anticipated outcomes, and ignores unanticipated consequences.

Outcomes in previous research assessing the effect of teaching EBP have been categorized somewhat differently by Nabulsi et al. [83]. Nabulsi et al. referred to the

following three categories: 1) *learner outcomes* (e.g. attitudes, intentions to use EBP, knowledge, skills, behaviour, satisfaction with training), *patient outcomes* (e.g. patient satisfaction, improved patient health/quality of life) and *health systems outcomes* (e.g. cost effectiveness). They further divided the learner outcomes into three domains: 1) *cognitive* (knowledge acquisition and skills), 2) *affective* (attitudes, beliefs and intentions, satisfaction with training) and 3) *behavioural* (use of evidence in clinical practice).

These domains described by Nabulsi et al. [83] resemble the three domains in Bloom's taxonomy (cognitive, affective and psychomotor), although, Nabulsi et al. do not mention this specifically and they do not take into account the different categories within these three domains. Bloom's taxonomy of educational objectives has been described as a framework for classifying statements of what can be expected from students [84]. Each domain in Bloom's taxonomy (revised version) contains a set of categories that differ in complexity, for example the cognitive domain/process contains the following six categories: remember, understand, apply, analyse, evaluate and create [84]. Within these six categories, a total of 19 cognitive processes can be identified. For example, *remember* (retrieving relevant information from long-term memory) involves recognizing and recalling, and *evaluate* (making judgments based on criteria and standards) involves checking and critiquing. Krathwohl [84] specified that, although there was a difference in complexity between these categories, "...the requirement of a strict hierarchy has been relaxed to allow for categories to overlap one another". Bloom's taxonomy has very recently been used successfully when conducting document reviews to understand the current level of EBHC teaching of medical and allied health curricula [78].

### ***Evidence-based practice outcomes relevant for this study***

A summary of EBP (learner) outcomes relevant for this study is presented below (Table 3), and related to different types of assessment methods (how), as recommended by Tilson et al. [55]. Here I mainly focus on the EBP outcomes described by Shaneyfelt et al. [73], in addition to the EBP outcome "self-efficacy", as described by Tilson et al. [55].



**Table 3.** EBP domains related to learner outcomes and types of assessment methods

EBP domains	What is assessed?	Type of assessment (How)
<b>Knowledge</b>	Learners' retention of facts and concepts about EBP (e.g. which study design is appropriate for specific questions).	Cognitive testing
<b>Skills</b>	Ability to apply knowledge by performing EBP steps (e.g. related to clinical scenario):	Performance assessment
Ask	Convert the need for information into an answerable question.	
Acquire	Track down the best evidence with which to answer a question	
Appraise	Critically appraise evidence (validity, impact, and clinical applicability).	
Apply	Apply the evidence in clinical decision making.	
<b>Attitudes</b>	Learner's values/beliefs related to the importance and usefulness of EBP to inform clinical decision-making.	Self-Report/ Opinion
<b>Self-efficacy</b>	Learner's confidence/beliefs in ability to perform EBP.	Self-Report/ Opinion
<b>Behaviours</b>	Learner's actual performance: Transfer of knowledge and skills to the workplace	Activity monitoring, or Self-Report/ Opinion
<i>Enacting EBP steps in practice</i>	Enacting the EBP steps (e.g. identifying clinical questions in the course of patient activities)	For example: <ul style="list-style-type: none"> <li>• Internet-based portfolio; EBP steps carried out related to real patient situations (e.g. electronically captured searching behaviour).</li> <li>• Self-reported use of the EBP actions.</li> </ul>

The different EBP outcomes, as described in Table 3 above are further described below.

*Knowledge* as an outcome of EBP teaching interventions has been defined variously as knowledge about EBP [73], or objective knowledge about EBP such as knowledge about information sources, concepts in critical appraisal, statistics, and epidemiological concepts [83]. Knowledge has also been described as learners' memory of facts or concepts about EBP such as the basic principles of EBP, the definition of EBP or levels of evidence [55]. Knowledge is also about grasping the

meaning, for example, understanding the meaning of epidemiological concepts such as Number Needed to Treat (NNT) [85].

*Skills* primarily refer to type of tasks associated with EBP, particularly related to performing EBP steps, for example conducting a search (information retrieval skill) or critically appraising in relation to a clinical scenario such as a standardized patient or a written case [55, 73, 83]. Ability to practice the 5-step model is described as core competences in EBP [86]. Each of these core competences will require several specific competences, as illustrated by the competency grid described by Greenhalgh and Macfarlane [86]. For example, before evaluating evidence there is a need for competence to distinguish relevant from irrelevant evidence, to determine completeness and quality and strength of evidence and to evaluate statistical validity. To evaluate statistical validity will require competency training related to critical appraisal and biomedical statistics, for example ability to generate NNTs when baseline risks and relative risks are provided [85, 86].

*Attitudes* have been defined as attitudes towards EBP [73], or even more specifically, as attitudes toward the medical literature as in perceived importance of facilitating the integration EBP into clinical practice, and attitudes towards the use of research information [87]. Recognizing the need for using EBP knowledge or skills in practice would reflect a positive change in attitude [85]. Tilson et al. [55] define attitudes as “the values ascribed by the learner to the importance and usefulness of EBP to inform clinical decision-making”. *Beliefs* is another term used to describe attitudes, for example, beliefs about the value of EBP [88].

*Self-efficacy* refers to learner’s perceived skills and confidence [83], or to their own judgment, *beliefs* or confidence regarding their ability to perform certain EBP activities [55, 88]. For example, self-efficacy reflects perceived EBP abilities to perform the five EBP steps and processes.

Accordingly, “*beliefs*” is a term that is used in relation to both attitudes and self-efficacy/capabilities, as in *beliefs* about the value of EBP (attitudes) and *beliefs* in implementing EBP in practice (self-efficacy) [88].

*Behaviours* refer to what learners do in practice, their actual EBP actions at the workplace, or behaviours can transfer to whether knowledge and skills are applied to the workplace [55, 73, 85]. The transfer of knowledge and skills will reflect: 1) the learner enacting of the EBP steps in clinical practice or 2) the learner performing evidence-based actions or processes (e.g. use of available research evidence in decision making, and integrating this with patient preferences, clinical experience and contextual factors) [55, 73, 87]. This latter way of assessing transfer to workplaces was not a focus in this study.

### ***Instruments used for assessing evidence-based practice learning***

Choice of relevant, valid and reliable instruments is essential in the assessment of educational interventions. Instruments or tools to assess EBP learning outcomes have been examined in several systematic reviews [73, 74, 89-93]. In the first systematic review on instruments for evaluating education in EBP, Shaneyfelt et al. [73] identified 104 unique instruments that had been administered primarily to medical students and postgraduate trainees. Most tools assessed critical appraisal skills, or searching skills, and only two cognitive or performance based instruments were identified that assessed all five EBP steps (The Fresno and the Berlin Questionnaire) [94, 95]. Flores-Mateo and Argimon [90] found that few studies that evaluated EBP teaching had used validated tools. They identified 22 instruments that had been used, and only 10 of these had two or more types of validity or reliability of evidence. No other tools were identified in a later review by Ilic [89], and the need for future tools to measure behaviour was emphasised. Malick et al. [74] found that no single tool covered the assessment of all EBP steps, and they also highlighted the need for tools that assess the application of EBM in practice. Glegg and Holsti [93] found that three out of 15 tools identified were adequate for the measurement of EBP knowledge and skills among rehabilitation professions: 1) the Adapted Fresno Test (AFT) [96, 97], a cognitive and performance based instrument, and 2) a self-report instrument developed by McCluskey and Lovarini [97], and 3) a self-report scale developed by Upton and Lewis [98]. This scale have later been revised [99] and Leung et al. [92] found that this was the only tool that had adequate validity for measuring knowledge, skills and

attitudes in EBP among nurses. In a systematic review by Upton et al. [100] the psychometric properties of this self-report instrument is further affirmed. Rengerink et al. [91] identified and compared tools for assessing EBP behaviours among health care professionals. They identified only one tool that assessed all five EBP steps, a self-report tool that has been used to assess nurses application of EBP in a national survey in Sweden [101].

Based on knowledge from these systematic reviews, it seems that the AFT [96, 97] is the only valid and reliable cognitive and performance based instrument that assesses EBP knowledge and skills among rehabilitation professions [93]. These reviews identified other relevant and promising instruments that assessed all five EBP steps. These are primarily tested among nurses [100, 101], and are based on self-report measures.

In a consensus statement on EBP assessment, Tilson et al. [55] recommended one other self-report instrument that focuses on all the five EBP steps and assesses behaviour: the EBP Beliefs Scale, tested among nurses [88]. They also recommended other instruments that assess self-efficacy: 1) the EBP Beliefs scale, tested among nurses [88] and 2) the EBP Confidence Scale, tested among health care professionals [102], or instruments that assess attitudes: 1) the EBP attitude scale, tested among mental health and social service providers [103] and 2) the Knowledge, Attitudes, Access and Confidence Evaluation (KACE) [104]. KACE is a cognitive test that also assesses knowledge.

## 1.5 Support for integrating evidence-based practice into clinical education

### *Research evidence*

The effect of different approaches to EBP teaching among postgraduates, have been investigated in two previous systematic reviews [85, 105]. Findings from these reviews indicated that teaching EBP is more effective when integrated into clinical practice and moved from classroom to clinical settings [85, 105]. Khan and

Coomarasamy [85] also found that interactive workshops are more effective than didactic teaching when it comes to improving learner outcomes and patient outcomes. Based on these findings they developed a hierarchy of teaching and learning methods for EBM/EBP: interactive and clinically integrated activities (Level 1); interactive but classroom based activities (level 2a); didactic but clinically integrated activities (level 2b); and didactic, classroom or standalone teaching (level 3).

These findings have subsequently been supported by findings in a recent overview of systematic reviews on the impact of teaching EBP among all types of learners (undergraduates and postgraduates) [106]. The different strategies that had been employed in EBP teaching were: lectures, tutorials, journal clubs, workshops, online courses and clinically integrated methods [106]. Some studies included in previous reviews described single interventions, whereas others describe interventions where strategies were combined; multifaceted interventions. In line with Coomarasamy and Khan's conclusions, Young et al. [106] concluded that interventions that were multifaceted, clinically integrated, and involved assessment, lead to improvements in EBP knowledge, skills and attitudes amongst all learners, and lead to improvements also in EBP behaviour among practicing health professionals. The findings by Coomarasamy and Khan [85, 107] and Young et al. [106] are in line with the overall idea behind this study, that learning EBP should be integrated into clinical education.

The need for integrating EBP into clinical education is further supported by findings from both quantitative (surveys) and qualitative research among undergraduate students from different professions. Results from a survey among undergraduate medical students showed that students struggled with searching for research evidence for their clinical queries [108]. Results from two other survey showed that medical students tended to have a questionable prioritization when it came to searching for research evidence during their clinical clerkship [109, 110], for example, they prioritized primary sources such as other clinicians, online sources or books [110]. Occupational therapy students reported of lack time and clinical instructors (CIs) not practicing EBP are potential barriers towards EBP [111]. Results from a survey among Swedish nursing students indicated that students received less support for EBP during

clinical education compared to academic education [112], and researchers also reported of low extent of research use one and three years after graduation [113, 114]. Similarly, findings from qualitative studies among nursing students indicated that sparse implementation of EBP was perceived as a barrier towards learning during clinical education [115], and both nursing students and undergraduate medical students saw the need for CIs that encouraged EBP [116-118].

### *Educational theory*

Findings from the systematic reviews on the effect of teaching EBP [85, 106, 107] reflect central tenets of sociocultural perspectives on experiential learning, in particularly Vygotsky's thinking and socio-cultural learning theory as communities of practice (COP) theory [119]. Both these theories originated in Soviet Russia and rooted in Marxist theory, which explains why the focus with these theories shifted from individual to social learning. Vygotsky [119] is regarded as the father of the socio-cultural tradition's and argued that *social and cultural interactions* were fundamental to the understanding of learning. One of his central ideas was the zone of proximal development, which he defined as:

*...the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” [120, p. 86].*

The zone of proximal development can be understood as “...a metaphorical space that defined the additional potential for learning resulting from interaction with other agents and structures” [119, p. e106]. This idea is relevant to learning in clinical settings. As stated by Spouse [121], learners need support and guidance from a more experienced learner (e.g. CI) when moving through their *zone of proximal development*, from a baseline of knowledge-in-use to the outer limit of knowledge-in-waiting. Through *social interaction* and problem solving CIs, or other experienced learners, can learn more about the students' actual development level, the level of potential development, and the need for guidance (scaffolding), with regard to EBP or other learning objectives. Scaffolding is a term that was introduced by Wood et al.

[122] and Bruner [123]. Although scaffolding as a term was not used by Vygotsky, the idea of scaffolding was evident in his work:

*Suppose that I show them (children) various ways of dealing with the problem...”; “...run through an entire demonstration and ask the children to repeat...”; “...initiate the solution and ask the child to finish it...”; “...offer leading questions...”; “...in some way or another I propose that the children solve the problem with my assistance... [120, p. 86].*

COP theory is also known as “Situated learning and Legitimate Peripheral Participation” [119], as introduced by Lave and Wenger [124, 125]. Students at clinical placements can be regarded as *legitimate peripheral participants*. Students have a mandate to be at the clinical placement as a student (legitimate), although not at the core of practice (peripheral) as the other clinicians and CIs, and they learn by taking part in the activities at the clinical placement (participants), as opposed to only observing [119]. Opportunity for being *legitimate peripheral participants* is essential in developing professional identity.

Yardley et al. [119] provided an overview of educational theory relevant to learning from experience, and they emphasized the following central themes in socio-cultural learning theories:

- Learning is *located in social milieus* rather than heads of individuals.
- Learning is an essentially *social* and cultural process.
- Learning involves *social interactions*.
- Students are novice members of a *community of practice*; and *legitimate, peripheral, participants* in this community.
- Learning is *situated* within the context where learning takes place, as it is difficult to separate the subject matter, content and processes of learning.
- Learning is *mediated by artefacts* with cultural and historical significance (e.g. sign, systems; language).

Accordingly, focus on learning in *social milieus* supports the importance of clinically integrated learning of EBP. In physiotherapy education there are good opportunities

for this, as clinical education is recognized as an important element in physiotherapy education [60, 126, p. 125]. During clinical education the COP is comprised of physiotherapists, other professionals, other students, patients and their family members [127]. Engagement in the social and cultural processes in the COP is dependent on formal mentors (CIs) [128], and the importance of the *social interactions* between students and CIs is important for students' knowledge growth and development [121, 129]. Subsequently, the interaction between students and CIs is also important with regard to learning how to use EBP in clinical settings. As emphasized in a central textbook in EBP "Evidence-based Medicine. How to Practice and Teach EBM", CIs can potentially serve as role models in EBP [26]. The need for role models with strong EBP skills, in particular among CIs, is a need that students highlight themselves [111, 115-118, 130].



## **2. Aims**

The overall aim of this study was to contribute to knowledge and understanding of how to ensure use of EBP in clinical physiotherapy education.

The specific aims of paper I-III:

### **Paper I**

The aim was to compare self-reported EBP behaviour, abilities and barriers during clinical placements reported by five cohorts of final year physiotherapy students with different level of EBP exposure across the 3-year bachelor programme.

### **Paper II**

The aim was to explore beliefs, experiences and attitudes related to students' use of EBP in clinical physiotherapy education among students, CIs and visiting teachers.

### **Paper III**

The aim was to assess the short and long term impact of an EBP program on the knowledge, skills, beliefs and behaviour of CIs supervising physiotherapy students.

### 3. Materials and methods

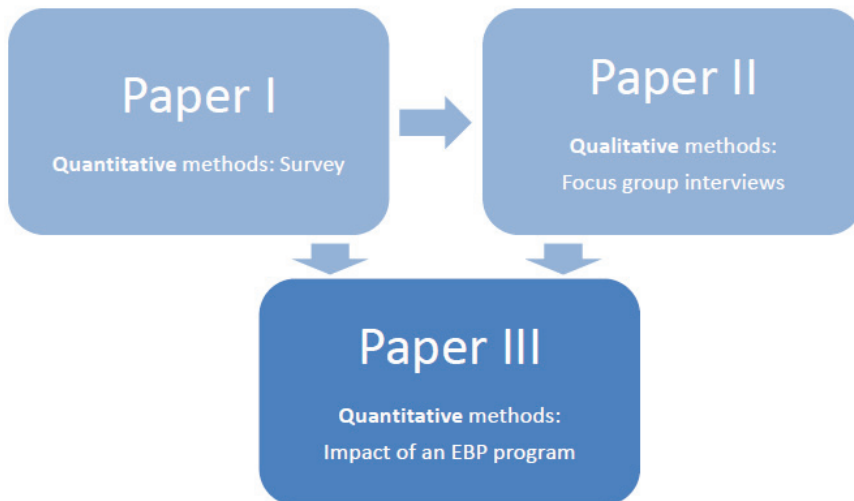
#### 3.1 Designs (Papers I-III)

To contribute to understanding and knowledge of how to ensure use of EBP in clinical physiotherapy education we conducted three studies with different designs: a cross-sectional study (survey) (Paper I), an interpretive descriptive study (qualitative interview study) (Paper II), and a non-randomized controlled study (Paper III) (Table 4). Quantitative and qualitative research methods were applied in a sequential order and reported as three distinct papers (Paper I-III). The planning of the third study was informed by results from the first two studies (Paper I and II) (Figure 1).

**Table 4.** Overview of materials and methods (Paper I-III)

Paper	Aim	Design	Sample	Data collection	Analysis
I	To compare self-reported EBP <sup>a</sup> behaviour, abilities and barriers during clinical placements among five cohorts with physiotherapy students with different EBP exposure.	<ul style="list-style-type: none"> <li>• Observational</li> <li>• Cross-sectional</li> <li>• Survey</li> </ul>	Third year students (n=180)	<i>Quantitative:</i> <ul style="list-style-type: none"> <li>• Questionnaire</li> <li>• Self-reported</li> </ul> <i>Year of data collection:</i> 2006-2010	Spearman's rho (r)
II	To explore beliefs, experiences and attitudes related to students' use of EBP in clinical physiotherapy education.	<ul style="list-style-type: none"> <li>• Interview study guided by interpretive description</li> </ul>	Third year students, visiting teachers and clinical instructors (n=32)	<i>Qualitative:</i> <ul style="list-style-type: none"> <li>• Focus group interviews (n=6)</li> <li>• Individual interview (n=1)</li> <li>• Interview in a pair (n=1)</li> </ul> <i>Year of data collection:</i> 2008	Constant comparative analysis
III	To assess the short and long term impact of an EBP program on the knowledge, skills, beliefs and behaviour of clinical instructors supervising physiotherapy students.	<ul style="list-style-type: none"> <li>• Experimental</li> <li>• Non-randomized controlled study</li> </ul>	Clinical instructors (n=37)	<i>Quantitative:</i> <ul style="list-style-type: none"> <li>• Questionnaires</li> <li>• Self-reported</li> <li>• Pre-, post- and follow up</li> </ul> <i>Year of data collection:</i> 2008-2009	Generalized estimating equations

<sup>a</sup>EBP=evidence-based practice



**Figure 1.** The first two studies (Paper I and II) informed the third study (Paper III).

### 3.2 Context (Papers I-III)

This study (Papers I-III) was set up in the context of physiotherapy undergraduate education at Bergen University College (BUC), which is one of four university colleges in Norway that offers a three year bachelor's program in physiotherapy [127, 131]. Students who successfully complete this bachelor program are awarded 180 credits according to the European Credit Transfer and Accumulation System (ECTS). One credit generally corresponds to 25-30 hours of work ([http://ec.europa.eu/education/tools/ects\\_en.htm](http://ec.europa.eu/education/tools/ects_en.htm)).

The bachelor's program in physiotherapy includes in total 30 weeks with clinical education (45 ECTS-credits), which involves completion of clinical placements lasting from a few weeks up to 11 weeks [127, 131]. Students must complete two longer clinical placements: an 11-week placement in primary health settings in year two (4<sup>th</sup> semester), and a 10-week clinical placement at hospital settings in year three (6<sup>th</sup> semester).

At clinical placement students are supervised or mentored by experienced physiotherapists. Plack [128] found that many different terms are used for this mentorship: sponsor, role model, coach, supervisor, preceptor, advisor, gatekeeper, guide, counsellor, and friend, and they have all been used synonymously with mentor. In addition, there is no consensus with regard to the function of a mentor. In physical therapy, students are assigned to a CI [128]. CI is also the term used by the WCPT [60] and in up-to-date text books describing teaching and learning in physiotherapy [132]. In the “WCPT guideline for the clinical education component of physical therapist professional entry level education” [60] there is a long list of responsibilities of the CI, among others: administrative support, orienting, planning learning activities, mentoring and supervising through the clinical experience, evaluating student performance, providing feedback, serving as role models and assuring best practice opportunities. The CI must also help in bridging the gap between theoretical and practical knowledge [128]. The interaction between student and the CI is central to student’s learning during clinical education [133, p. 160].

Physiotherapy students at BUC are assigned to a CI, who provides supervision and guidance. These physiotherapists can work in various settings, such as primary health care, outpatient clinics, rehabilitation clinics, local hospitals and university hospitals [127]. The CIs involved in this study (Papers II and III) worked in different hospital settings. Physiotherapy students at BUC also have to relate to a teacher from the university college (academic staff). These teachers are referred to as visiting teachers. They visit students at the placements, and are the connection between the university college and the placement.

After graduation, students must spend an additional year in a supervised internship in hospital practice and primary health care. This internship is a requirement for qualifying as a certified physiotherapist.

### 3.3 Paper I

#### *Sample*

Throughout the study period, 274 full-time third year physiotherapy students, from five consecutive cohorts (2006-2010), were enrolled in the three year bachelor's programme in physiotherapy at BUC. Only those students who had completed the final 10-week clinical placement in Norway were eligible to participate in the study (n = 246).

#### *Setting*

All these students had been exposed to EBP during their bachelor's degree either in stand-alone sessions where didactic lectures and interactive activities were combined or in other learning activities where EBP was integrated (Table 1, Paper I). The level of EBP exposure, as in the amount of teaching and type of training, differed between the student cohorts. Students who graduated in 2006 received a small amount of EBP in stand-alone sessions (7 hours), and were not required to use EBP in other learning activities (low EBP exposure). Students who graduated in 2007 and 2008, received an increasing amount of EBP in stand-alone sessions (16-26 hours), and used EBP skills with PBL activities in year 3 (medium EBP exposure). Students who graduated in 2009 and 2010 received a high amount of EBP in stand-alone sessions (30 hours), and used EBP skills in several learning activities across the three year programme: in exams, when discussing PBL scenarios and in academic assignments and patient reports from clinical placements (high EBP exposure).

#### *The questionnaire*

The questionnaire was divided into three sections (Table 5) (Appendix I). Section one addressed background data. Section two addressed issues related to use of EBP during clinical placement, such as self-reported EBP behaviour, perceived ability to practice the EBP steps and perceived barriers. Response alternatives for these items were related to degree or to frequency. The two final items in section two addressed the number of articles read during clinical placement. In total, section two consisted of 40 items. In section three participants were given the opportunity to comment upon

missing issues, layout and other limitations with the questionnaire. In addition to questions on EBP, the questionnaire contained background questions about sex, age and access to Internet.

**Table 5.** Overview of questionnaire sections

Section	Questions about	Response alternatives
1	Background data	Yes/No
2	<ul style="list-style-type: none"> <li>• EBP behaviour (25 items)</li> <li>• EBP abilities (3 items)</li> <li>• EBP barriers (10 items)</li> <li>• Number of articles read (2 items)</li> </ul>	<i>Degree</i> (to a high degree, to some degree, to a little degree and not at all), or <i>Frequency</i> (often, sometimes, seldom and never)
3	Comments about questionnaire (2 items)	Open-ended

This questionnaire was developed by academic staff (physiotherapist) experienced with teaching EBP. The content of this questionnaire was based on relevant literature on the EBP steps [9, 26, 134] and literature that had identified typical barriers towards EBP, such as lack of time, resources, skills and EBP culture [135-137].

Minor adaptations were made to the questionnaire before the data collection in 2008. Five ambiguous items related to use of EBP during clinical placement were removed. These adaptations were based on experiences with the questionnaire so far, and feedback through an interview with two students who had responded to the questionnaire previously. In addition, we added some background questions: age, clinical placement location, and participation in qualitative interviews (Paper II).

### *Data collection*

Data was collected retrospectively in the period 2006 and 2010 using the paper-based questionnaire described above (Appendix 1). The questionnaire was delivered in a debriefing session on students' first day back to college after the clinical placement. Researchers gathered completed questionnaires, and data were stored securely within the university college premises.

## *Analysis*

To facilitate the data analysis we categorized the different level of EBP exposure into “low”, “medium” and “high”, based on the amount of training and type of training (for more details see Paper I). For descriptive purposes, response alternatives for items in the questionnaire were categorized as “1” when related to a low degree (to a little degree or not at all) and low frequency (seldom or never); and categorized as “2” when related to a high degree (to some degree or to a high degree) and high frequency (sometimes or often) (Table 5). Response alternatives concerning how many articles students read (0, 1–2, 3–5, 6–10 or 11–20) were recoded into two categories: “0–2 articles” and “three or more articles” (Table 5).

We used Spearman’s rho ( $r$ ) to investigate any correlation between the level of EBP exposure (low, medium or high) and third year physiotherapy students’ self-reported EBP behaviour, abilities and barriers. We also calculated Cronbach’s alpha for the items related to EBP behaviour, abilities and barriers. The Pearson Chi-Square test for independence was used to test an association between the number of articles read and the level of EBP exposure. For all analyses p-values less than 0.05 significant were considered significant.

## **3.4 Paper II**

### *Sample*

The aim of the interpretive descriptive [138] study required inclusion of participants involved in clinical physiotherapy education: physiotherapy students, physiotherapists functioning as CIs and academic staff functioning as visiting teacher. These different participant-categories were recruited purposively to participate in interviews.

Students from BUC, their visiting teachers and the CIs situated at hospitals in Bergen, were all invited to participate in focus group interviews. For practical reasons, CIs situated at hospitals outside Bergen were invited to participate in individual interviews, since hospitals outside Bergen are situated far apart, and few CIs are situated at each of these hospitals. CIs situated at hospitals outside Bergen were invited to participate in

the study to ensure the perspective of CIs that were not working at university hospitals, or were geographically close to BUC or centres of excellence (e.g. Centre for Evidence-Based Practice). BUC provided contact information and a complete list of potential study participants (n=97): Students from BUC (n=55), visiting teachers from BUC (n=7), CIs (n=21) situated at hospitals in Bergen (Haukeland University Hospital and Haraldsplass Deaconess Hospital), and CIs situated at various hospitals outside Bergen (n=14).

In total, 32 persons agreed to participate: 16 students, 12 CIs (three from hospitals outside Bergen) and four visiting teachers. Students who participated in this study were expected to have a certain level of EBP knowledge and skills after being exposed to EBP in stand-alone sessions across the three year bachelor program (in total 26 hours). These students had used EBP with PBL activities in year 3 (medium EBP exposure). Half of the students who participated in this study (Paper II) also responded to the questionnaire in the cross-sectional study (Paper I) (n=8), and four of these eight students were interviewed after they responded to the survey.

### *Data collection*

Focus group interview was the primary data collection strategy in this study. Interviews with three different participant-categories (n=32) were conducted during spring 2008: three focus group interviews with students, two focus group interviews with CIs in Bergen and one focus group interview with visiting teachers (Table 6). Conducting focus groups interviews with different participant-categories is described as a multi-category design [139, p. 31]. This design allowed comparison of perspectives and interactions within and between the different participant-categories. In addition, we conducted one individual interview with one CI and one interview with a pair of CIs from hospitals outside Bergen (Table 6).



**Table 6.** Overview of participant-categories and type of interviews

Participant-categories	Participated (invited)	Type of interview				
		Focus group interviews			Individual	Interview in pair
		Group 1	Group 2	Group 3		
Students	16 (55)	6	6	4		
CIs <sup>a</sup> in Bergen	9 (21)	5	4			
CIs <sup>a</sup> outside Bergen	3 (14)				1	2
Visiting teachers	4 (7)	4				

<sup>a</sup>CIs=Clinical instructors

Prior to the interview sessions, all study participants were asked to fill in a form about general demographic data. For all interviews we used a semi-structured interview guide (Appendix 2) based on the aim of this study, our current contextual understanding of the problem and previous relevant research. Interviews lasted 1–2 hours and were digitally recorded, and transcribed verbatim by a secretary/student. The first author (NRO) conducted all the interviews. All the focus group interviews were co-facilitated by two different assistant moderators.

### *Analysis*

Constant comparative analysis [29, p. 522-529, 138, Chapter Eight] of the focus group data was conducted during the following phases: 1) immersing in the transcripts, 2) developing an initial template (Appendix 3) [140, 141], 3) organizing the interview data based on codes in the template, 4) condensing and reflecting, 5) comparing and contrasting within interviews with similar participant-categories, and finally 6) comparing and contrasting between interviews with different participant-categories. Condensing the meaning of the interview data by summarizing what was said by the participants was done to ensure that there was good basis for further analysis. When reflecting on the summary, questions were asked about: “what is the meaning of what the participant says” and “is there something that the participants do not say, that perhaps would be expected?”. In table 7 below, I illustrate how the analysis was conducted in phase three and four, how interview data was organized based on one specific code from the template, how the data was condensed, what reflections that were made, and potential themes that emerged.

**Table 7.** How data was organized and condensed; reflections and potential themes.

Template code	Interview data*	Condensed meaning	Reflections	Potential themes
EBP behaviour related to searching	<p>«I have mostly used my supervisors experience...I have not been so good at searching for research evidence».</p> <p>«I believe it can be much easier to go directly to someone who has a lot of experience, often you feel this is more time efficient compared to searching for research evidence oneself.»</p> <p>«Yes, it is about time, right, first you have to search and then you have to consider if it is what you looked for, and then you have to read it, and then you have to evaluate the article, that is to use the criteria to find out if the article can be applied at all...it is a very long process compared to finding this information in a local clinical guideline, or asking your supervisors.» (Interview one, statements from a discussion between three students)</p>	<p>Students seem to experience that practicing evidence based (searching for research evidence in this instance) is a <i>long process</i>; searching, evaluating using criteria from checklist.</p> <p>Instead of searching for research evidence themselves, students seem to experience that it is <i>easier</i> and more time efficient to use local clinical guideline, or <i>go straight</i> to someone who has the right experience, e.g. <i>clinical instructor</i>, to get the answers they need.</p>	<p>Time seem to be a <b>barrier</b> for practicing evidence based (searching for research evidence).</p> <p>Is it <b>lack of competence in searching for research evidence</b> (a barrier) that explains why students experience that it is easier and more <b>time efficient to use local clinical guideline, or go straight to someone/clinical instructors (role model)</b> who has the right experience to get the answers they need; example of <b>searching behaviour</b>.</p> <p>Or are there other reasons that lack of time – like how much time and energy students have/are willing to use – after a day at work; is this also a question about <b>attitude/negative attitude towards evidence-based practice</b>?</p>	<p>Barrier = Time.</p> <p>Barrier = Lack of competence in searching for research evidence.</p> <p>Clinical instructors=role model (potential role model in evidence-based practice).</p> <p>EBP behaviour/searching behaviour.</p> <p>Barrier = negative attitudes towards evidence-based practice.</p>

\*After immersing in the transcript and developing an initial template based on the immersing/reading of the transcripts, interview data was organized according to the codes in the template/copy/pasted into this table.

Table 8 below illustrates how the analysis was conducted in phase five when comparing and contrasting between interviews with students (similar participant-categories).

In the final phase of inquiry, the individual interview and the interview in pairs (Table 6) served as an external clarification and validation for the emerging conclusions from the focus group interviews. Following these six phases the aim was to generate patterns in the form of relationships between overarching and integrative themes that weaved together various themes and codes from the complete data set.

**Table 8. Comparing and contrasting within interviews with similar participant-categories (students).**

Template	Summary interview 1 (n=6)	Summary interview 2 (n=6)	Summary interview 3 (n=4)	Reflecting across interviews	Potential themes
<p>Searching behaviour (student perspective)</p> <ul style="list-style-type: none"> <li>• Patient case: spinal stenosis; no experience; asked other therapists, found information based on research evidence in LCG</li> <li>• Patient case: Guillain-Barré syndrome; information from LCG, searched on internet, not easy.</li> <li>• Patient case: balance problems and strengthening exercises;</li> <li>• In general: Students experienced that searching took time; gave up; more time efficient to ask someone; long process from searching to evaluating to applying research evidence – compared to asking clinical instructor; if they searched – searched alone, acknowledged the need for competence in searching.</li> <li>• One student mentioned; often searched via the NHL</li> <li>• One visiting teacher mentioned the importance of using different knowledge sources</li> </ul>	<ul style="list-style-type: none"> <li>• Patient case: heart failure; student confused about research conclusions concerning effect of exercise; looks in books, internet,</li> <li>• Patient case: Radial nerve injury; do not find a clear answer by looking for studies on prognosis in Cochrane, Pedro, or literature from the school.</li> <li>• Patient case: Pain in shoulder/neck area; many clinical findings, needed more knowledge but lacked precise question(s), tried different databases (Cochrane, Pedro, Medline) felt lost; found some articles she could use (unclear how).</li> <li>• One student did not find anything in books, tried Pedro; found a lot of articles and read the abstracts briefly</li> <li>• One student mentioned that did not receive supervision on how to search, although informed about essential books, and some local clinical guidelines – instead showed clinical instructor how to search</li> <li>• One student mentioned; most important is communication with clinical instructor</li> <li>• Rather search after working hours; since takes a long time; can be tiring</li> <li>• In general: Search for the patient report</li> <li>• Felt pressured to search during problem based learning at school; lost inspiration after this,</li> </ul>	<ul style="list-style-type: none"> <li>• Patient case: Do not understand what oxygen saturation means and search for information</li> <li>• Patient case: patient with amputation; found one article and discussed with peer student and clinical instructor</li> <li>• Patient case: patient with knee prostheses; did not find any articles with concrete suggestions of exercise regime</li> <li>• Positive feedback from clinical instructors; good at asking and finding answers, searching and reading</li> <li>• Often used medical dictionary</li> <li>• Found Google time efficient; although more critical to this source compared to Cochrane Library</li> <li>• Used internet resources for medical doctors, user organisations</li> <li>• Find it easy to use Cochrane Library and Medline, although Pedro is more difficult – this student was a resource at her placement and was asked to search there</li> <li>• One student says she has not searched; another could not manage to download full text – wish this was a better service concerning that it takes up to two weeks to order articles; and when you also are supposed to critically appraise after this; cannot be bothered.</li> </ul>	<p><b>In all interviews:</b> most students mentioned that they have tried to search in databases, and are aware of Cochrane, Medline/PubMed and Pedro.</p> <p><b>In all interviews:</b> Some (at least two) patient situations where students experienced a need for searching for information – and in fact did so.</p> <p><b>In all interviews:</b> students often finds something, but seldom specifically what they need</p> <p><b>In all interviews:</b> no students asked precise and focused questions; often complex questions (e.g. balance and strength), or to specific/wide (e.g. anything about patients with amputations).</p> <p><b>In all interviews:</b> seem to lack competence as in asking precise enough questions for their search, finding the right search terms, go to the “wrong database” (e.g. Cochrane for studies on prognosis), believe Google is more efficient – although do have a sceptical attitude towards Google.</p> <p><b>In all interviews:</b> no examples of students doing good searches (systematically); they do not talk about/find systematic research, finds several articles on a topic and do not know how to choose between them.</p> <p><b>In all interviews:</b> have a need for basic and background knowledge, about diagnosis, symptoms, search for the meaning of words in medical dictionaries, use books; in interview 3; seem to need recipes, seem to need suggestions for exercises, in interview 1; did not search in the beginning of the placement; knew little and did not know where to start.</p> <p><b>In all interviews:</b> time is a barrier, searching takes time, takes time to order articles from the library, rather spend time with patient, priorities practice experience more than theory</p> <p><b>In all interviews:</b> visiting teacher not mentioned as one that can influence their searching behaviour; one student mention that teacher talk about sources</p> <p><b>Interview 2+3:</b> students know more about searching and receive positive feedback about this.</p> <p><b>Interview 1+2:</b> Talk about searching in relation to patient report.</p>	<p><b>Attempt searching for research evidence;</b> although, few examples where students conduct searches related to real patient situations.</p> <p><b>Barrier = Lack of competence in searching for research evidence:</b></p> <p>Go for “easy” solutions (Google) and <b>struggle</b> to find research information they can apply to patient situation, due to <b>lack of EBP/searching competence/competence in formulating questions.</b></p> <p>Need for recipes and more need for background knowledge; novices?</p> <p><b>Barrier = Time.</b></p> <p><b>Barrier: prioritise practice experience over research evidence.</b></p> <p><b>Idea future intervention:</b> Use patient report to promote/require use of evidence-based practice.</p> <p><b>Idea future intervention:</b> student a resource for clinical instructor</p>	

## 3.5 Paper III

### *Sample*

During the autumn 2008, physiotherapists working at different hospitals in Norway who were assigned the role as CIs for 3<sup>rd</sup> year physiotherapy students at BUC, were asked to volunteer for the study via e-mail (n=37). CIs at hospitals situated in Bergen were invited to participate in the intervention group (n=17), and CIs at hospitals situated outside Bergen were invited to participate in the control group (n=20). This pragmatic decision was based on consideration of time and cost of travelling, as the geographical distances between Bergen and hospitals situated outside Bergen are fairly large (up to 400 km), and few CIs are situated at each of the hospitals situated outside Bergen.

### *Intervention*

The intervention was a six-month multifaceted and clinically integrated training program in EBP (6 ECTS-credits) where focus was on the EBP steps and processes. Several different teaching strategies were used: workshops, assignments, supervision and exams (see program details described in Paper III, Table 1).

Interventions with several components is often referred to as complex interventions [142]. Other recognized aspects of complexity are: 1) Number of interacting components within the experimental and control interventions, 2) Number and difficulty of behaviours required by those delivering or receiving the intervention, 3) Number of groups or organizational levels targeted by the Intervention, 4) Number and variability of outcomes, and 5) Degree of flexibility or tailoring of the intervention permitted [143]. Dizon and Grimmer-Somers [144] suggest that EBP training within allied health care should be considered as a complex intervention. Aspects of complexity of the intervention in Paper III are illustrated in Table 9.

**Table 9.** Aspects of complexity reflected in the intervention

Aspects of complexity	Complexity aspects with the intervention
Number of interacting components within the experimental and control interventions	<ul style="list-style-type: none"><li>• Multifaceted training program with several teaching strategies with different format: workshops (lectures, small group work), group meetings, assignments, exams, supervision and feedback.</li></ul>
Number and difficulty of behaviours required by those delivering or receiving the intervention	<ul style="list-style-type: none"><li>• Teachers had to have knowledge and skills in EBP, and physiotherapy and research in order to deliver the program, and had to be able to assess and give feedback on assignments/exam.</li><li>• Participants had to attend, be engaged and interactive during workshop. In addition, they had to be able to deliver written assignments and relate content to real clinical situations.</li></ul>
Number of groups or organizational levels targeted by the Intervention	<ul style="list-style-type: none"><li>• Participants varied with age, gender, years of experience, type and size of position, other post-graduate education – and job location.</li></ul>
Number and variability of outcomes	<ul style="list-style-type: none"><li>• Formative assessment (written assignments).</li><li>• Summative assessment (oral exam).</li><li>• Outcomes used for the research project: knowledge, skills, attitudes/beliefs and behaviour.</li></ul>
Degree of flexibility or tailoring of the intervention permitted	<ul style="list-style-type: none"><li>• Individual feedback to students via phone and/or email, including guidance from librarian when necessary (tailored to the students need).</li></ul>

Table 9 is inspired by Mattick et al. [145].

Educational theory that underpinned the intervention was the socio-cultural learning perspectives, emphasising that learning should be interactive, situated, and triggered by real patient situations [119, 124, 146].

## *Questionnaires*

### **Translation procedure**

The AFT, the EBP Belief Scale and the EBP Implementation Scale was translated to Norwegian using a forward and backward translation procedure, as described by the World Health Organization [147]. The original versions of all the questionnaires were translated into Norwegian (forward translation), followed by a review process by an expert panel made up by experts in EBP (n=4) and researcher experienced with instrument translation (n=1). A professional translator performed the backward translation of the questionnaires into English. The backward translated versions were discussed with all the authors of the questionnaires to ensure that the content of the translated questions were conceptually equivalent to the original questions. Next, discussions were held with a pair of physiotherapy students (n=2) and practicing nurses (n=3). For each question, they were asked to repeat the questions in their own words, to explain what they thought the questions were asking; and to express if there were any words they did not understand. A discussion was also held with three

colleagues with EBP competence (three nurses, one OT). Written feedback on the translations was provided by three physiotherapists. Items that clinicians or students found difficult to understand were further discussed with the authors of the instruments. After a last discussion with the expert panel we agreed on the final versions of the questionnaires.

### **Scoring of the Adapted Fresno Test**

The AFT consist of three versions that include identical items, but different sets of clinical scenarios (Appendix 4) to help minimize practice effects when AFT is used for pre-, post- and follow-up testing [96]. For each of these versions there is an English scoring matrix that was only slightly modified for use in this study. For practical reasons, these three versions of the scoring matrix were integrated into one single scoring matrix (Appendix 5). In the original scoring matrix raters are instructed to consider the responses to question 5-7 as one response, because issues raised in these questions may be arbitrary subdivisions of the process of critical review. However, this specific instruction was not used in the modified scoring matrix, as these questions in fact request different information (study relevance, validity, magnitude and significance). Consequently, raters were asked to score responses to question 5 applying the criteria related to question 5 in the scoring matrix, and the same procedure for question 6-7.

Before scoring the AFT tests, a training session was conducted using examples of scored and unscored copies, a similar procedure as described by McCluskey and Bishop [96]. When scoring the AFTs, raters used a score sheet (Appendix 6), also developed by McCluskey and Bishop [96]. An example of a score sheet and responses is provided in Table 10.

**Table 10.** Sample score sheet with participant responses, marks and scores.

Question	Participants' response	Scoring categories	Mark awarded	Summed subtest scores	
<b>Q1</b> Write a focused clinical question for ONE scenario to help you organize a search of the clinical literature.	Persons with osteoarthritis (OA) of the knees	Population	3/3	9/12	
	Home-based exercise program	Intervention	3/3		
	No intervention	Comparison	1/1		
	Improved mobility	Outcome	2/1		
<b>Q2</b> Where might you find answers to these questions? Name as many possible sources of information as you can. List advantages and disadvantages.	Guidelines, databases, colleagues, books	Variety	6/6	22/24	
	Quality ensured by others (systematic review)	Convenience	4/6		
	Relevance, not answering "my" question	Clinical relevance	6/6		
	Outdated, quality unsure, evidence-based	Validity	6/6		
<b>Q3</b> What type of study (design) would best answer your clinical question and why?	Randomized controlled trial	Study design	12/12	15/24	
	Effect of intervention , control group compared to intervention group	Justification	3/12		
<b>Q4</b> Describe the search strategy you might use in Medline; topics, fields, rationale, and limits.	P: OA knees	I: Home-based Exercise program	C: Treatment in clinic	O: Pain mobility	22/24
	Explains use of MESH	Thesaurus/MESH	8/8		
	AND/OR	Delimiters	6/8		
<b>Q5</b> What characteristics of a study determine if it is relevant?	Is my clinical question comparable to research question in article? Is the design used in article the best for answering this question?	Study characteristics	0/12	0/24	
		Subject characteristics	0/12		
<b>Q6</b> What characteristics of a study determine its validity?	Drop outs, study design, allocation concealment, randomization	Internal validity	18/24	18/24	
<b>Q7</b> What characteristics of the study's findings determine its magnitude and significance?	P-value, confidence-interval	Magnitude	0/12	9/24	
		Statistical significance	9/12		
			<b>Total score</b>	95/156	

The AFTs collected in this study (n=76) were scored independently, during a two-week period, by two raters with a good understanding of EBP (first author, and a nurse with a PhD and experienced with teaching EBP). Agreement between the raters was measured calculating intraclass correlation coefficients (ICC) type 2, 1 (random effect model) [148]. Agreement between raters was very good for all the total AFT scores (Version 1: ICC 0.89, 95 % Confidence Interval 0.74-0.95; Version 2: ICC 0.95, 95 % CI 0.88-0.98; Version 3: ICC 0.97, 95 % CI 0.92-0.99) (Table 11).

**Table 11.** Inter-rater Reliability of the AFT based on total and subtests scores

Question	AFT Version 1		AFT Version 2		AFT Version 3	
	ICCs	CIs	ICCs	CIs	ICCs	CIs
1	0.58	0.51-0.82	0.74	0.50-0.88	0.97	0.93-0.99
2	0.91	0.81-0.96	0.86	0.70-0.93	0.87	0.72-0.94
3	0.89	0.77-0.95	0.94	0.86-0.97	0.88	0.74-0.95
4	0.88	0.75-0.94	0.87	0.73-0.94	0.87	0.72-0.94
5	0.77	0.56-0.89	0.75	0.52-0.88	0.88	0.75-0.95
6	0.55	0.23-0.76	0.89	0.78-0.95	0.92	0.82-0.97
7	0.62	0.34-0.80	0.88	0.74-0.94	0.89	0.76-0.95
<b>Total score</b>	0.89	0.74-0.95	0.95	0.88-0.98	0.97	0.92-0.99

AFT=Adapted Fresno Test, ICC= intraclass correlation coefficients, type 2, 1 (random effect model), CIs=confidence intervals

ICCs were good to very good for all summed subtest scores for version 2 and 3, with all ICCs above 0.70. The summed subtest scores for version 1 were good to very good and above 0.70 for question 2, 3, 4, 5 and 7. ICC for question 1 and question 6, version 1, was however moderate (Q1: ICC 0.58, 95 % CI 0.51-0.82; Q6: ICC 0.55 95 % CI 0.23-0.76). Due to the questionable levels of reliability among raters for the summed subtest scores (Version 1, Q 1 and Q6) - raters made an effort to reach a consensus score for all the AFTs (n=76). The two raters discussed their initial scoring and agreed on a consensus score; solving disagreement by discussing question-by-question. These consensus scores were used for the analysis. Both raters were blinded to the status of the AFTs, as to whether the tests were from the control or the intervention group.



### *Data collection*

Data were collected at three different measurement times: at pre-intervention in September 2008, at post-intervention in May 2009 and at follow-up in November 2009. To assess the impact of this multifaceted and clinically integrated training program in EBP we used three previously validated questionnaires: 1) AFT [96, 97] (Appendix 4), 2) the EBP Belief Scale [88] (Appendix 7), and 3) the EBP Implementation Scale [88] (Appendix 8) (for more details on these instruments see descriptions in Paper III). In addition, all participants filled out demographic sheets at pre-intervention (September 2008). Permission to translate and use the three questionnaires was obtained from its developers.

### *Analysis*

To estimate differences in total mean scores we used generalized estimating equations (GEE) [149, p. 62-77] to account for correlated data imposed by the study design with repeated measures of the outcome. To investigate time dependent group differences we included an interaction term between group and measurement time in the regression models. In these analyses, an unstructured working correlations structure was applied and standard errors were calculated using robust estimates. We performed additional analyses to adjust for potential confounding by age, gender, type of position, size of position, type of post-graduate education and years of experience. Estimated differences in outcomes were reported as mean difference (MD) with 95 % confidence interval (95 % CI). P-values less than 0.05 were considered statistical significant for all analyses.

Internal consistency for all outcome measures was calculated using Cronbach's  $\alpha$ . Alpha values of  $\geq 0.70$  were regarded as satisfactory for comparing groups [150].

## **4. Ethical and legal issues**

### **Study I**

Prior to completing a questionnaire, physiotherapy students were informed about the following: the purpose of the survey, and the voluntary nature and anonymity of participation. Completion and submission of the questionnaire implied informed consent. As we did not collect information that could be used to identify individuals, ethics approval was not required under Norwegian regulations.

### **Study II and study III**

The Regional Committee for Medical and Health Research Ethics, Western-Norway, exempted both these studies from review, because these studies did not include medical or biomedical aspects (Appendix 9 and 10). The Norwegian Social Science Data Services (NSD) approved both studies. The project number at NSD is 18407 (Paper II) (Appendix 11) and 20311 (Paper III) (Appendix 12).

In keeping with the approval from NSD, we obtained written informed consent prior to interviews (Paper II) and prior to the intervention (Paper III). To preserve confidentiality written data and recordings were stored appropriately. Recordings from the interviews and personally identifiable data collected in relation to the intervention were deleted after end of project. Anonymity of participants in interviews (Paper II) was preserved by eliminating names from transcripts. In addition, all participants in interviews were referred to as “she” in the paper II, since only three participants were men.

Both these studies were supported by all of the involved institutions: BUC, Haraldsplass Deaconess Hospital and Haukeland University Hospital.

## 5. Summary of results

In this chapter, a condensed summary of results from study I –III will be presented. The comprehensive presentation of the results is available in the respective papers (paper I-III).

### 5.1 Paper I

Olsen, N. R., Lygren, H., Espehaug, B., Nortvedt, M. W., Bradley, P., & Bjordal, J. M. (2014). **Evidence-based Practice Exposure and Physiotherapy Students' Behaviour during Clinical Placements: A Survey.** *Physiotherapy Research International*. doi: 10.1002/pri.1590.

In this study we investigated if there was an association between different EBP exposure across the 3-year bachelor programme and self-reported EBP behaviour, abilities and barriers among final year physiotherapy students during clinical placements.

In total, 180 out of 246 third year physiotherapy students from five cohorts (2006-2010) at BUC completed a questionnaire on EBP behaviour, abilities and barriers (response rate of 73 %). The association between the level of EBP exposure (low, medium and high) and students' self-reported EBP behaviour, abilities and barriers during clinical placements was low for most items in the questionnaire. Statistically significant correlations were found for eight of the 40 items. The strongest correlations were found between the level of EBP exposure and items concerning: ability to critically appraise research evidence ( $r = 0.41$ ,  $p < 0.001$ ); perceived critical appraisal skills as a barrier ( $r = -0.31$ ,  $p < 0.001$ ); use of databases (e.g. Medline) ( $r = 0.26$ ,  $p < 0.001$ ); use of checklist to critically appraise research evidence ( $r = 0.26$ ,  $p < 0.001$ ); and search for research evidence ( $r = 0.22$ ,  $p < 0.003$ ). With regard to participants' reported ability to critically appraise research evidence, 17% perceived some or high degree of ability to critically appraise research evidence with low level EBP exposure as opposed to 57% with high level EBP exposure. In addition, a statistical significant association was observed between EBP exposure and the participants' self-reported reading of English articles ( $p = 0.004$ ).

## 5.2 Paper II

Olsen, N. R., Bradley, P., Lomborg, K., & Nortvedt, M. W. **Evidence based practice in clinical physiotherapy education: a qualitative interpretive description.** *BMC Medical Education* 2013, 13(1), 52. doi: 10.1186/1472-6920-13-52.

In this study, we explored beliefs, experiences and attitudes related to third year physiotherapy students' use of evidence based practice in clinical physiotherapy education. Participants varied between the ages of 21 and 55 years, and most students were below the age of 30 years (See Table I, Paper II). Five of the participants were men. Few CIs had post-graduate education related to EBP and only one CI had a master's of science. Two of the visiting teacher had a master's of science and two had doctoral level preparation.

We identified four overarching and integrative themes that wove together various themes and codes from the complete data set: "attempt to apply EBP", "novices in clinical practice", "prioritize practice experience over EBP" and "lack role models in EBP". "Attempt to apply EBP" is related to students' struggle with searching for research evidence and to applying this knowledge during clinical placements. One potential explanation for our findings could be that students were "novices in clinical practice" who needed more time to learn new routines at the placement and needed basic background information more than research information. Students also experienced that it was more time efficient to use CIs or other therapists as their information source, rather than searching for research evidence. In addition to leaning on their clinical instructors, students were more eager to "prioritize practice experience over EBP", believing that it was more important to spend time on gaining practical experience than practicing evidence-based. This prioritizing was supported by CIs and visiting teachers. Although there were some examples of CIs who searched for and used research evidence, students noticed "a lack of an EBP culture", as EBP was not part of the routine practice at the clinical placement. Thus, it is not surprising that participants believed there was a "lack of EBP role models". Both students and CIs perceived a need for role models in EBP; in particularly, CIs must have interest and competence in EBP to ensure EBP in future clinical education.

## 5.3 Paper III

Olsen, N. R., Bradley, P., Espehaug, B., Nortvedt, Lygren, H., Frisk, B, M. W., & Bjordal, J. M. (2014). **Impact of a training program in evidence-based practice on clinical instructors' knowledge, skills, beliefs and behaviour: A longitudinal controlled study.** PLoS One. 2015;10:e0124332.

In this study we evaluated the short and long term impact of a multifaceted and clinically integrated training program in EBP on the knowledge, skills, beliefs and behaviour among CIs.

We invited CIs situated in Bergen (n=17) to participate in the intervention group, and CIs situated outside Bergen to participate in the control group (n=20). In total, 29 agreed to participate (78.4 %); 14 in the intervention group and 15 in the control group. Participants in the intervention group and the control group were similar at baseline with respect to all participant characteristics. In total, 13 from the intervention group and 9 from the control group, contributed with information at each measurement. Most participants were female (n=26), and their mean age was 39.7 years (26-61, SD 9.9). Participants' mean years of experience was 12.9 years, and ranged from 2 to 32 years (SD 8.6). More than half of the participants had some kind of postgraduate education: one had a master's degree, four had a course in research method, two had a course in EBP, and nine had other physiotherapy related post-graduate courses. Few participants held a leadership position (n=3), and one-third of the participant were specialist physiotherapists. The majority of the participants held 80-100% of full time equivalent positions (n=28).

At post-intervention, the GEE regression analyses showed statistically significant differences in favor of the intervention, for all three outcome measures. At follow-up, the group difference was statistically significant for two of the outcome measures: the AFT (mean difference = 37, 95% CI (15.9 -58.1),  $P < 0.001$ ) and the EBP Beliefs scale (mean difference = 8.1, 95% CI (3.1 -13.2),  $P = 0.002$ ). Over time, a statistically significant increase in mean scores related to all outcome measures was found for the intervention group only, when baseline scores were compared to scores post-program and follow-up, respectively.

## **6. Discussion**

### **6.1 Methodological considerations**

In this section I will consider methodological choices for all papers included in this study (Paper I, II and III). I will start the discussion with focusing on overall design choices. Subsequently, I will discuss methodological issues related to the qualitative paper (Paper II), followed by separate discussion on methodological issues related to the two quantitative papers (Paper I and III). I organized the discussion this way for two reasons. Firstly, procedures used in qualitative and quantitative research are very different due to the different types of questions asked and the different nature and assumptions of the data collected [151]. Secondly, the two quantitative papers also differed with regard to choice of design (experimental and observational) and the nature of our assumptions (focus on describing relationships and cause-and-effect relationship). Consequently, different methodological considerations were required for all three papers.

#### **6.1.1 Overall design**

In this study different research methods were combined in a sequential manner to investigate the aim of this study (Table 4, Figure 1). Qualitative and quantitative strategies should be thought of as complementary, and viewing a problem from different angles like this makes it possible to increase the understanding of a complex phenomenon [151].

Data from the cross-sectional study (Paper I) indicated that students lacked the necessary skills and knowledge to apply research evidence during clinical education. For example, a relative low percentage of the 2006 cohort reported that they sometimes or often used research evidence in real clinical situations (48%) or searched for research evidence in databases (35%) during clinical placements. None of the students from this cohort reported that they sometimes or often used checklists to critically appraise research evidence. Results from this study indicated that efforts

were needed to ensure EBP knowledge, attitudes, skills and behaviour among students in clinical placements. However, before initiating such efforts a better contextual understanding was needed to inform future interventions. For example, more knowledge was needed about: who should be the target population for an intervention; what type of intervention was needed (e.g. content, way of delivery, feasibility issues); and, what could explain the findings reported in the survey (e.g. low percentage reporting use of research evidence, barriers). To achieve a better understanding of the meaning and implications of such findings qualitative studies can be added [151], as shown in the interpretive descriptive study (Paper II). Findings from this study (Paper II) gave us a better understanding of why students struggled to use EBP during clinical education. Students were novices; prioritized practice experience over EBP; and lacked EBP role models which indicated that CIs role modelling EBP could be the first step towards ensuring use of EBP in clinical education. Consequently, in the third study the focus was on evaluating the impact of a clinically integrated teaching program in EBP among CIs. Together, Paper I-III provide a more comprehensive account and contextual understanding of how to ensure EBP is actually used by students during their clinical education.

Our approach is in line with that proposed by the medical research council (MRC) [152] in the United Kingdom, who recommend that both qualitative and quantitative methods can be used to develop and evaluate complex interventions. Recently, researchers within (medical) education have also been recommended to look to the MRC framework for evaluating complex interventions [145]. As pointed out in this framework, and by several other authors, preliminary work, such as focus group interviews and/or surveys (as employed in this study) can be used to help define relevant components of interventions or larger-scale quantitative studies [139, p. 24, 142, 151].

## 6.1.2 Qualitative study (Paper II)

In the paper II we used interpretive description as a research strategy as described by Thorne [138]. According to Thorne, our appreciation of *credibility* of qualitative research goes beyond considering methodological rules or traditional evaluative criteria, and extends into how findings can be interpreted and applied [138, p. 223]. Health professionals, including physiotherapists, have a moral obligation to provide services that benefit patients and the society [138, p. 223]. Nevertheless, it is crucial to thoughtfully consider the quality criteria for data generation and analysis, and how conclusions were achieved [138, p. 101]. In evaluating credibility Thorne [138, p.102] suggests the following quality criteria : 1) epistemological integrity, 2) representative credibility, 3) analytical logic and 4) interpretive authority.

### *Epistemological integrity*

To achieve epistemological integrity the research questions must be consistent with the stated epistemological standpoint (i.e. interpretive description) [138, p. 223]. With our research questions we focused on exploring beliefs, experiences and attitudes related to students' use of EBP in clinical physiotherapy education. Our aim was to produce knowledge and a contextual understanding of how to ensure students' use of EBP in future clinical physiotherapy education. Aiming to produce knowledge and an understanding that could be *applied* and have implications for practice; is consistent with using interpretive description as a research strategy. According to Thorne [138, p. 33] interpretive description extends “beyond mere description and into the domain of the “so what” that drives all applied sciences”; and aims to explore meanings and explanations that can be *applied*, and thus will have implications for practice [138, p. 33, 153, p. 6].

Epistemological integrity also requires that interpretation of data sources and interpretive strategies follows logically from the research question [138, p. 224]. To explore our research question we invited different participant-categories (Table 6), and *constant comparative analysis* enabled us to exploit similarities and differences regarding perspectives and interactions within and between these participant-



categories (Table 7 and 8). This interpretive strategy enabled us to generate patterns and themes, in addition to noticing exceptions. In this study there were several examples of students attempting EBP, but one student made an obvious greater effort than the other students to co-operate with her CIs in finding and critically appraising research evidence (see citation referring to “Student 4, Interview 3” in Paper II). As stated by Miles and Huberman [154, p.269] “...a good look at the exceptions...can test and strengthen the basic findings...protect you against self-selecting, and may help you build a better explanation. In this way interpretive description offered a coherent strategy that enabled us to generate new and comprehensive insights regarding students’ use of EBP during clinical education.

### *Representative credibility*

Representative credibility concerns whether the findings presented are consistent with sampling strategies [138, p. 224]. Our findings reflected the perspective of students, CIs and visiting teachers, on students’ use of EBP during clinical education. These findings are consistent with our sampling strategy, as we intentionally selected all types of participants who typically were involved with clinical physiotherapy education: third year physiotherapy students and their CIs and visiting teacher (Table 6). Intentionally selecting an appropriate sample that will most benefit the study, and who have experience with the phenomenon studied (i.e. students’ use of EBP during clinical physiotherapy education) is referred to as purposeful sampling strategy [29, p. 355, p. 360, 155, p. 112].

In addition, we choose to interview different participant-categories (students, CIs and visiting teachers) who naturally held different perspectives on the phenomenon studied, ensuring maximal variation and comparability; and Thorne [138, p. 224] recommends maximal variation before certain claims can be attempted. A purposeful sample focusing on variation can promote alternative hypothesis and nuances of interpretation otherwise not possible [156, p. 59]. Triangulation of different data sources/perspectives (e.g. interviewing different participant-categories) is one way of recognizing “...knowledge beyond a single angle of vision” and confirming our

perceptions [138, p. 224]. In addition, triangulation of different types of data collection methods (focus group interviews and individual interviews) enabled us to assure consistency of findings by different methods. In Paper II we state that the individual interview and the interview in pairs served as an external clarification and validation for the emerging conclusions from the focus group interviews. Although it is not uncommon to combine methods in this way for the purpose of data confirmations, we could perhaps have made a greater effort to visually depict how these different data sets were compared, and how they actually contributed to the understanding of the phenomenon of interest [157].

Appropriate sampling method is not a guarantee for a sufficient description of the sample; how do we know if we managed to "...provide data without any "thin" spots" [29, p. 360]? Although there are no rules for sample size in qualitative research – and sample size is a matter of judgment and experience [29, p. 357, 158], we need to question whether the sample size was adequate to achieve descriptions that were richly textured and complete. Some experts within qualitative research emphasise the importance of saturation (a point where no new information is obtained, data has become repetitive and redundant, and further data collection cannot result in new information) [29, p. 357, 360]. Thorne [138, p. 98] is of another opinion and argues that "...the idea that one can claim that now new variation could emerge seems antiethical to the epistemological foundations of practice knowledge", and she calls for a more honest assessment of the results of the interpretive description. It is difficult to be certain that our sample size was large enough, but we need to recognize that findings may have been different if we had interviewed an even larger sample. According to McPherson and Thorne [159] larger samples could create even greater opportunities, and this an important mechanism for testing "...the degree to which our findings are sufficiently comprehensive, nuanced and inclusive to make a meaningful contribution to evidence-based practice." Furthermore, we could learn more about our phenomenon by interviewing participant categories affiliated to other bachelor's-level education in Norway. Interviewing a similar population for other national bachelor programs could identify potential geographical differences, and our finding could then have an even broader credibility.

Then again, specific descriptions of context and key characteristics of the participants that are provided in the paper (Paper II, Table 1) may be sufficient to assist readers/consumers to evaluate the degree of congruence between our sample and a similar population at another site. To provide such descriptive information of both the context and the sample in which the study was carried out - is necessary for readers of qualitative research evidence; to ensure that they are able to determine which situations they might transfer the findings to (referred to as “external validity”) [29, p.360-361, 151].

### *Analytical logic*

Analytical logic refer to steps taken to making accessible to readers the adequacy of the decision making process [138, p. 225]. In paper II the steps or phases of both data collection and analysis are listed and explained fairly detailed. However, it can be questioned whether these details are sufficient for readers to understand the different decisions that led to the findings. Ideally we should have documented and displayed visually this process even more detailed, for example by applying the principles of audit trail [160]. An audit trail could provide evidence of the processes from the raw data to the different analysis processes (see for example: <http://www.qualres.org/HomeAudi-3700.html>). Examples of how this could be done for some of the analytical processes in this study (organisation of the data based on the template, condensing and reflecting, comparing and contrasting within and between interviews) are provided in this study (Table 7 and 8). What adds credibility (reflexivity) in this study is the fact that multiple analysts co-operated around most of the analysis phases (operations), which enabled us to understand the data in different ways and avoiding biased or selective perceptions.

### *Interpretive authority*

Interpretive authority refers to the importance of ensuring that it is possible to grasp the researcher’s intentions [138, p. 225]. For example, the positioning of the researcher must be transparent in the research report. In our study, we clarified that all interviewers were positive towards EBP and familiar with using or facilitating EBP in

academic or clinical settings. Our positive attitudes towards EBP could result in us not being sensitive enough towards the challenges related to students' use of EBP during clinical education. However, our interpretations reflect that our analysis was more balanced as we noticed and reflected both on students attempting to practice evidence-based (“positive” findings) and the various challenging the experience in these processes (“negative” findings).

Interpretive authority also refers to the importance of readers needing assurance regarding trustworthiness of the researchers' interpretations [138, p. 225]. Building in systems to check if participants “agree” with researchers' interpretations could be one way of ensuring interpretive authority. However, this type of member-checking could lead to false confidence if participants confirm the interpretations or it could disrupt analytical process if they don't [138, p. 159]. In cases where participants do not agree it could be difficult to decide which interpretation to choose. For this reason, we did not share our interpretations. However, we were interested in knowing if there were any essential issues that we had not paid enough attention to. Therefore, we e-mailed the participants the summaries of main issues brought up during the focus group interviews and asked them to read through the summaries and reflect upon if there could be any issues they would like to add that they had not thought of during the interviews, or if they had any other comments. Ideally, the moderator or interviewer should critically question what participants say and give them the opportunity to express if they agree with the moderator's interpretations [161, p. 149]. However, this could disturb the group dynamics/discussion. Therefore, when moving from one topic to another the moderator briefly summarized the discussions and interpretations up to that point – giving participants the opportunity to refute the interpretations.

### **6.1.3 Quantitative study (Paper I)**

This was a non-experimental or observational study in that we did not intervene by manipulating the independent variable (EBP teaching integrated into the curriculum), [29, p. 271]. In non-experimental studies a presumed cause and effect may be identified and measured (i.e. EBP related outcomes as a result of EBP teaching), but

other features of experiments are missing, for example, random assignment, or design elements such as pretest and control groups [162, p. 18]. This cross-sectional study can also be categorised as a descriptive correlation design as we aimed to compare and to look for correlations. Studies with correlation design are better at describing relationship among variables (e.g. associations between different level of EBP exposure and use of EBP) than inferring cause-and-effect relationship [29, p. 275].

In general, there are often several alternative explanations for findings in cross-sectional studies [29, p. 208]. We collected data at a single point from five different cohorts of students in the period between 2006 and 2010 and we need to recognize that this design and time frame challenges our ability to infer changes over time [29, p. 208]. For example, we cannot be confident the changes that we described are related to exposure to different levels of EBP they could also be due to the result of time passing and the number (and speed) of social and technological changes in our society.

Moreover, we cannot exclude the possibility that other unknown factors may have influenced our results, and in part could explain the associations we found. Ideally, we should have controlled for potential contaminating factors, extraneous or confounding variables, and other factors that may have been related to the independent variable [29, p. 198]. Factors such as confidence in academic level (e.g. other bachelor degrees), confidence in clinical decision making and clinical preparedness –have been identified as predictors related to bachelor (nursing) students' present and future use of EBP [163]; and could be potential confounders. However, we were not familiar with this knowledge at the commencement of our study, and therefore did not consider controlling for these factors.

Another potential source of bias (i.e. a major concern that may threaten the study's ability to reveal the truth [29, p. 197]) could be related to the questionnaire used in this study. We need to question the validity of this instrument; to what degree it measured what it was supposed to measure [29, p. 457]. Efforts were made to ensure that the included items reflected essential issues relevant to EBP attitudes, barriers and behaviour by reviewing relevant literature [9, 26, 51]. In addition, we interviewed two

students about their understanding of items; no items were changed, but we removed five ambiguous questions. These actions ensured a basis for establishing content validity, which is relevant for ensuring representative questions and capturing the full content domain (conceptualization of the construct) [29, p. 458]. Content validity could have been further assessed using qualitative inquiry (e.g. focus group interviews), extensive literature review and systematic approaches involving calculation of validity indexes; these efforts would have strengthened construct validity. We did however establish that the internal consistency was acceptable for most items; indicated by the Cronbach's alpha values showing that different subparts of the instrument reliably measure the critical attribute (e.g. 0.67 for EBP behaviours, 0.53 for EBP abilities and 0.72 for EBP barriers). Although evaluating internal consistency is a common reliability approach, it is a limitation of this study that we did not also evaluate other reliability issues, such as stability (e.g. test-retest reliability) [29, p. 453].

Ideally we should have used a previously validated questionnaire for this study. However, at the commencement of our study that was not alternative. Another promising questionnaire assessing knowledge, attitudes and behaviour was published in 1998 [98], but this questionnaire was more suitable for clinicians than students, and it was not thoroughly validated [164]. In addition, this questionnaire was not identified as a suitable questionnaire in the systematic review by Shaneyfelt et al. [73]. Other relevant and valid questionnaire were developed by 2006, but they were not published until after the development of protocol and questionnaire for our study [52, 165].

Self-report is a common data collection method, and often this is the only way of learning more about how people think, feel, believe or behave [29, p. 369]. However, the nature of self-report data could be a threat to the accuracy and the validity of self-reports. It is well known that we all have a tendency to present ourselves in the best light. Accordingly, *social desirability* could be a bias in our study; in particular, concerning reports of EBP abilities and behaviour. For example, Lai and Teng [166] demonstrated that self-perceived competence in EBM did not correlate well with objectively assessed EBM competence measured using the AFT. An alternative to self-

report is observing behaviour; however, it is difficult as it would only be possible to observe behaviours occurring at that specific time of the study. As measuring actual behaviour is challenging, Eccles et al. [167] argue that intention (self-reported measures) appears to be a valid proxy measure for behaviour for use in the development of implementation interventions. Then again, others suggest that behaviour should be measured using some form of activity monitoring [55, 73], and examples of this do exist. Translation of EBP knowledge, skills and attitudes or beliefs to real-time EBP behaviour - could be explored, for example, by observing and audiotaping EBP behaviour (e.g. during precepting or supervisory sessions with students) [73, 168, 169].

In this study we asked students to think back to their clinical placement and to give a retrospective account about their past use of EBP during the 10 week clinical placement. Although we endeavored to reduce *recall bias* by collecting data at the students' first day back at the school, it could still be difficult for students to remember details regarding their behaviour and barriers they experienced. It could be even more difficult to remember frequency of activities (e.g. number of articles read). We need to acknowledge that this retrospective element of our design could have resulted in unaccurate and unreliable answers.

A central assumption within EBP is that "...study findings are not unique to people, places, or circumstances of the original research" [29, p. 202]. This is a question about *generalizability*, whether other educators can rely on and apply evidence from this study (Paper I) in their own educational practice. In addition to the biases pointed to earlier in this discussion, *generalizability* of result from this study to other (undergraduate) settings and (undergraduate health care or physiotherapy) students could be hampered due to the relatively small sample and the fact that the sample was based on students from a single institution in Norway. However, similar and comparable findings from previous international research support the fact that our findings are not unique to our sample and context [170, 171].

### 6.1.4 Quantitative study (Paper III)

In paper III we assessed the impact of an EBP program on CIs' EBP knowledge, skills, beliefs and behaviour before and after the intervention, and at six-month follow-up using a non-randomized controlled study. This design is often referred to as quasi-experimental and is characterized by the purpose of testing descriptive causal hypotheses about manipulable causes (i.e. the impact of an intervention/EBP training program), the presence of a control group accompanied by pretests and posttests on the same type of outcome measures to facilitate causal inference [162]. However, random assignment that characterizes randomized controlled studies (“true experiment”, “gold standard”) is lacking.

Randomly assigned groups would entail that participants are assigned to intervention or control group by chance (e.g. tossing a coin), creating groups that are probabilistically similar to each other [162]. Whether a randomized controlled trial (RCT) or a non-randomized controlled trial is the design, it is essential to evaluate all the possible factors or threats that undermine validity of inferences [29, p. 286]. However, without randomly assigned groups it is even more problematic to trust if the differences observed between the groups at the end of the study are due to the intervention or differences that existed between the groups at the start of the study. Thus, quasi-experimental designs (i.e. Paper III) that lack randomly assigned groups run the risk of less support for counterfactual inferences that can be a threat to validity [162, p. 14].

Shadish et al. [162, p. 34] use the term validity to refer to “...the approximate truth of inference”; and state that it involves making “...a judgment about the extent to which relevant evidence supports that inference as being true or correct.” Validity judgments are not absolute as it is not possible to be certain that inferences from experiments are true. Shadish et al. [162, p. 38] present an approach to generalized causal inference that involves four types of validity: 1) statistical conclusion validity, 2) internal validity, 3) construct validity and 4) external validity. This typology was initially proposed by Cook and Campbell in 1979 [172].



This typology of four different types of validity is used as a framework for the discussion of methodological concerns with regard to the non-randomized controlled trial (Paper III).

### *Statistical conclusion validity*

Statistical conclusion validity concerns "...demonstrating that there is, in fact, an empirical relationship between the independent and dependent variable [29, p. 291-292]. The ability to detect if there is a true relationship between the independent and dependent variable is determined by statistical power. *Low statistical power* is one essential factor that can be a threat to statistical conclusion validity [162, p. 45]. One way of ensuring statistical power is ensuring a sufficiently large sample, as statistical power tend to be low with small samples. Despite the small sample size in our study, we achieved statistically significant changes for all pre- and post-intervention comparisons on the 5 % level, indicating that the impact of training is reasonably large.

*Unreliability of measures* is another factor related to statistical conclusion validity [162, p. 49]. This could refer to the quality of the measurements. We used three previously validated questionnaires instruments for assessing the impact of the educational program of this study: 1) The Adapted Fresno test (AFT) [96, 97], 2) the EBP Belief Scale [88], and 3) the EBP Implementation Scale [88]. We found that scoring of the AFT was reliable, indicated by very good agreement between raters all the total AFT scores, and the summed subtest scores for version 2 and 3 (Table 9). We could have settled with averaging the final scores for the two raters and (only) reached a consensus score for the summed subtest with questionable agreement among raters (the summed subtest for version 1, Q1, Q6); similar to what has been done previously [173]. However, to be confident that the scores for all the AFTs (n=76) used for analysis were correct, the two raters discussed their initial scoring and agreed on a consensus score for all the AFTs (n=76). This was a very time consuming process. Future studies need to look at procedures for scoring (including further development of the scoring matrix) and aiming for even better ICCs for all summed subtest. Such processes require carefully selected and trained raters [174]. In addition, we should

have conducted a test-retest comparison of all outcome measures. Efforts were also made to investigate internal consistency, and Cronbach's alpha was satisfactory for all instruments at pre-intervention, including the EBP Beliefs scale (0.85), the EPB implementation scale (0.85) and the AFT (0.93). Processes during the translation of these instruments ensured content validity (e.g. discussions with students, colleagues and involvement of an expert panel). We recognize that further efforts should have been made to evaluate other reliability issues, such as stability (e.g. test-retest reliability) [29, p. 453], and validity, both in the context of our study. It is however a strength of this study that other authors (in addition those behind the instruments) have established that the AFT is a valid and reliable tool for the assessment of evidence-based practice knowledge and skills in various settings and among different types of participants [174, 175]. Other authors have also established validity and reliability (e.g. internal consistency, construct validity, concurrent validity, criterion validity) of the EBP Beliefs scale and the EPB implementation scale in other settings (e.g. in China, Iceland) [176, 177].

Statistical conclusion validity can also be influenced by the strength of the intervention, referred to as treatment fidelity or *unreliability of treatment implementation* [29, p. 294, 162, p. 50]. To ensure full force of the intervention, the intervention should be as standardized as possible (e.g. by using protocols, training of personnel) [29, p. 294]. In our study, we only offered the intervention once so all participants received the same intervention. It is also recommended that the intervention is implemented as planned (same intervention to all participants, ensuring no access to control group participant) [29, p. 294]. Adequate description of the interventions is essential, for example, Olson and Bakken [178] emphasise that such information is necessary for reviewers to draw conclusions about the relationship between the educational approach and outcomes. Detailed reporting of the intervention is also emphasized by a group of researcher who are currently working on the development of reporting guidelines for educational intervention for EBP [179, 180]. In line with this development, our intervention was planned and described in detail (Paper III, Table 1.). However, there is always a risk that there could have been differences in the delivery of individual supervision offered to participants in relation

to the different assignments, as four different supervisors were involved. To ensure that participants did receive similar supervision from the different supervisors, the group of supervisors discussed problematic issues, and the participants had the opportunity to come together as a group to meetings to openly discuss different challenges with their assignments (Paper III, Table 1.).

*Heterogeneity of participants* can influence statistical conclusion validity [162, p. 51]. As such, validity threats can be related to inadequate control over confounding variables. For example, for designs using non-equivalent control group design different participant characteristics can have an effect on the independent variable (i.e. EBP training program), and need to be controlled. Controlling for this variation can be done through statistical analysis [29, p. 289]. In this study we performed additional analyses to adjust for potential confounding by age, gender, type of position, size of position, type of post-graduate education and years of experience. These are typical demographic variables that are recommended to measure and control [29, p. 290]. In addition, we could have identified other confounding variables through a literature review [29, p. 290]. After the EBP training intervention was completed - a systematic review of the individual determinants of research evidence use in allied health was published [181]. Authors of this review point to several relevant factors that we already did control for, among others: educational degree, academic qualification including involvement in research or EBP-related activities (i.e. responsibility for professional development).

### *Internal validity*

Polit and Beck [29, p. 295] defines internal validity as:

...the extent to which it is possible to make an inference that the independent variable is truly causing or influencing the dependent variable and that the relationship between the two is not the spurious effect of a confounding variable”.

When using quasi-experimental design there are several competing explanations of what caused the outcomes or threats to internal validity [29, p. 295]. Most importantly,

there is a risk of systematic pre-existing differences between groups, and if this is the case – the outcomes can be explained by other factors than the intervention itself (independent variable). This is referred to as *selection bias*, and is presumed to be present in non-randomized controlled studies where groups are nonequivalent by definition [162, p. 138]. However, we tested both the control group and the intervention group pre-intervention (using the same instruments/same timing at all measurements), and therefore we could explore and rule out systematic differences between the groups, both with regard to pre-test (pre-intervention) measurements and background variables. If the groups had differed at the pre-intervention measurement we would be more worried about threats to internal validity. The absence of pre-test differences does however not prove that a selection bias was not present. Shadish et al. [162, p. 138] point out that other unmeasured variables could potentially cause selection and correlate with the outcome (e.g. see previous discussion on *heterogeneity* of participants).

In the period from the start of EBP training program and the follow-up period, natural changes could potentially have occurred as a function of time, referred to as *maturation* [29, p. 296]. Physiotherapists working in typical university hospital settings (i.e. intervention group) feel part of a research-oriented culture [182, 183] – and could potentially mature more than physiotherapist in non-university hospital settings (i.e. control group). As a consequence, the CI in the intervention group could have experienced a growing interest in EBP as a result of more and more colleagues over time increasingly adapting EBP attitudes and behaviour. We cannot be confident that this did *not* happen, but at the same time – we do not expect such changes taking place in such a relatively short period (8 months) without any specific interventions being implemented.

Another risk we need to consider is *selection history*, which can occur if other events occur concurrently with the intervention and between pre-test and post-test and influence the outcome in the absence of the intervention [29, p. 295, 162, p. 56]. We were confident that other events (e.g. professional development opportunities) did not take place at the same time as the training program. Several of the persons in the

research/project group worked at the hospitals (HUS and HDS), and would know if other events took place.

In our study, there were several points of data collection: pre-intervention (pre-test), post-intervention (post-test) and follow-up. *Attrition* biases should be analysed when there are multiple points of data collection [29, p. 298]. This type of bias refers to occasions where participants in the intervention fail to complete parts of or all of the outcome measures [162, p. 59]. Participants in our study did fail to complete parts or all of the outcome measures (Paper III, Figure 1). In the control group, one participant failed to respond at post-intervention, and five participants withdrew from the study (2 at post intervention, and 3 at follow-up). Several methods are used to account for missing data [184]. For example, GEE is recommended as a valid method of analysis when drop-outs are missing completely at random, as an alternative to other statistical methods such as imputation methods [185]. With GEE we were able to include all subjects without imputation of missing values. Missing data in our study could still result in post-test outcome differences, and we need to question if the difference we found between groups was due the impact of the intervention or due to the drop-outs (had lower/higher scores initially). As there was no statistical difference between the participants at pre-intervention with regard to participant characteristics or baseline measures (all outcome measures), we do expect that the difference we found between groups at post-test and follow up was due the impact of the intervention.

### ***Construct validity***

Treatments, outcomes, settings and people are all stand-ins for general constructs and construct validity requires a match between the exemplars and the constructs. There are many potential threats to construct validity, and some relevant threats for this study are: reactivity to the study situation and research expectancies. *Reactivity to the study situation* refers to the well-known Hawthorne or placebo effect, where participants' behaviour can be attributed to awareness of their participation in the study. This could be the case when it comes to participants self-reporting EBP beliefs and barriers, but I would argue that our assessment of EBP knowledge and skills using AFT is less susceptible to reactivity. It is not likely that changes in knowledge and skills can be

attributed to awareness of their participation in the study. As mentioned previously, all researchers involved in this study held positive attitudes towards EBP, and there is a risk that our *researcher expectancies* were communicated in a subtle way and influenced the impact of the intervention. For the same reason as mentioned above, the use of an objective test as the AFT protected against this threat. Construct validity also requires careful attention towards what we call things, as for example the term EBP. Although the internal consistency analyses of all outcome measures indicate that the items in the instruments measure the same thing, we do not know how effectively the instruments measured EBP beliefs or EBP behaviour. We did make an effort during the translation process to examine the understanding of the different items (content validity) but should have made a greater effort to explore more thoroughly the construct validity of the specific content of items in the instruments (e.g. how do participants understand the meaning of EBP) in the context of our study.

### *External validity*

The change we found in the AFT scores (EBP knowledge and skills) can be considered educationally important change, as we achieved improvement of more than 10% or 15.6 points (mean difference=43, 95% CI (29.7 -56.4),  $p<0.001$ ) in the mean total score at post-intervention and more than 15% or 23.4 points (mean difference=37, 95% CI (15.9 -58.1),  $p<0.001$ ) at follow-up. None of the previous studies on the EBP scales have established what is considered educationally important change, or investigated sensitivity to detect change [175]. Such information would be useful for evaluating issues related to generalizability of studies where the scales are used, and further efforts are needed to establish this knowledge.

We cannot be confident that the findings in our study among CIs affiliated to hospitals could be *generalized* to CIs in community settings, or to CIs in other countries. Physiotherapist working in university hospital settings might feel more skilled, more engaged, and experience higher expectations and demands related to EBP (e.g. research use) [182, 183]. In addition, the positive attitudes in our project group, and the fact that the project was indeed supported by the organizations involved could

mean that an equivalent EBP training project never could be totally replicated - and that different results would be obtained in subsequent tests.

## 6.2 Discussion of results

### *Positive attitudes, but struggled to apply evidence-based practice*

Findings from both the cross-sectional study (Paper I) and the interpretive descriptive study (Paper II) indicated that students were positive towards EBP, but they struggled when trying to apply EBP in real patient situations. Recognizing that students struggle to apply EBP and understanding why is important for understanding the efforts needed to ensure use of EBP in clinical education.

Students struggling to apply EBP is a finding that concur with results from previous surveys [108-112] and qualitative research [115, 117, 118], including a very recent qualitative study [186], where authors stated that nursing students perceived EBP as “daunting and difficult to understand”. Despite challenges related to using EBP, these nursing students were positive towards EBP and perceived EBP as necessary for their future practice [186]. Similarly, findings from our studies (Papers I and II) indicated that students held positive attitudes towards EBP, as they attempted to practice EBP through searching and using research evidence. Positive attitudes towards EBP among students have been documented in numerous studies [111, 112, 163, 187-191].

Positive attitudes towards EBP do not necessarily ensure adoption of EBP behaviour, neither among students nor clinicians. In a systematic review of barriers, enablers and interventions among physiotherapists, Scurlock-Evans et al. [192] identified several studies that reported of physiotherapists with positive attitudes failing to implement EBP. This is contrary to several studies within nursing where a link between EBP beliefs and behaviour has been shown in several studies [193-197]. Results from a recent survey [198] conducted among Swedish nursing students (n=1319), showed a statistical significant correlation (0.21,  $p < 0.001$ ) between self-reported intentions to use research in the final semester of undergraduate study and research use behaviour at first year after graduation. However, this correlation [198] was not strong, and a large

percentage (44%) of the sample reported only a modest level of intention to use research evidence. This indicates potential weak evidence for the correspondence between intentions and behaviour among students. Other authors have also shown that self-perceived competence in EBP (self-efficacy) does not necessarily correlate with actual performance, again, neither among students nor clinicians [166, 199]. Accordingly, there is no clear evidence that EBP attitudes (intentions), beliefs or self-efficacy will predict EBP behaviour. This highlights the need for assessing EBP behaviour more objectively, for example by activity monitoring (e.g. learning portfolios [200]), or objective cognitive testing [55, 73]. We need to know if learners really apply their skills in actual practice [55, 73, 91].

Whether students really have the necessary knowledge and skills to transfer research evidence to real patient situations have been questioned [115]. It is likely that lack of sufficient knowledge and skills can explain why students struggled to apply EBP in real patient situations (Papers I and II). We found that a high percentage of students reported that they perceived barriers such as lack of knowledge in scientific methods (65%), lack of searching skills (52%) and lack of critical appraisal skills (52%) to some degree or high degree (Paper I). Findings from the interpretive descriptive study (Paper II) supported these findings. Students experienced frustrations and low confidence in relation to searching for research evidence. When they applied research evidence, they did this without consideration of validity. In addition, few of these students seemed to have experience with using knowledge sources such as systematic reviews or clinical guidelines, sources that are considered helpful to better seek evidence-based information [56, 57].

In general, the level of information competency among the students that participated in our studies need to be questioned (Papers I and II). More than 90% of the students reported that they approached their supervisor or another therapist to gain more knowledge (Paper I), and this information seeking behaviour was unaffected by the level of EBP exposure. This is in line with findings from the interpretive descriptive study that also indicated that students perceived it more convenient and efficient to turn to their CIs than searching the research literature (Paper II). Such findings are not



surprising considering that students are novices that lack experience [35, 37], and naturally will lean on their CI. At the same time it could be expected that these students who were soon to graduate, would have achieved a higher level of information competency together with a developing clinical expertise [34, p.67].

Results from the cross-sectional study showed that a low percentage of students reported to sometimes or often look for a paper in the library (43 % with high EBP exposure) during clinical placements, whereas a higher percentage of students reported that they to some or high degree searched databases as Medline (67 % with high EBP exposure). However, we do not have any knowledge about the quality of their searches. Findings from the interpretive descriptive study indicate that students searched without success, and they lacked a strategy for their search. This perhaps explains why they experienced that searching took too much time (Paper II). Our students are typical members of the millennial generation (born after 1982) and it is possible that their search behaviour is similar to students from other disciplines. Studies [201, 202] on search behaviour among various undergraduate college students (e.g. science, business and music) from this generation, indicate a questionable searching or information behaviour. Students made limited attempt to evaluate quality or validity of information gathered [201], and they found it more convenient to consult their peers and tutors, instead of a librarian [201].

The information or searching behaviour illustrated in our papers and previous research does not necessarily only pertains to students. In a study among physiotherapists and occupational therapists [203] information from peers was considered faster, more “to the point” and more important than research literature. In addition, results from a state-of-the-art review of research utilization in nursing and allied health suggest that clinicians prefer interpersonal sources of knowledge [204, p. 261-262]. Generally, lack of EBP skills, including searching skills, has been documented as a common barrier among physiotherapists and other allied health professionals in systematic reviews [192, 205] and qualitative research [182, 203, 206].

The lack of EBP knowledge and skills among both students and clinicians could explain why results from studies among physiotherapists show *underutilization* of effective treatments [4-7], and *overutilization* or *misuse* of treatment modalities not supported by research evidence [8]. Lack of EBP competence among clinicians, students and future graduates, calls for further efforts within education, and improvements can potentially reduce the current gap between existing knowledge and what is done. Future graduates need competence to find, use and evaluate research evidence (EBP step 1-3). This is essential competence, in particular when considering the enormous volume of clinical research in health care. Within physiotherapy several studies show that there is an increase in the amount of research evidence to guide physiotherapy interventions, and the quality of research is improving [207-211]. Sherrington et al. [212] point to the fact that the number of RCTs and systematic reviews of physiotherapy interventions has doubled every 3 ½ years. Despite the available evidence, physiotherapists and other health professionals report that the lack of generalizable and relevant research is a barrier towards EBP.

To ensure EBP competence among undergraduates and future graduates, it is recommended that EBP is integrated across the curriculum, including into clinical education [9, 18-20, 213]. Students who participated in both our studies (Papers I and II) were exposed to a curriculum where EBP was integrated across the curriculum (Paper I, Table 1). Still, we found a low association between the level of EBP exposure and students' self-reported EBP behaviour, abilities and barriers. The association was somewhat stronger between the perceived ability to critically appraise research evidence ( $r = 0.41, p < 0.001$ ) and lack of critical appraisal skills as a barrier ( $r = -0.31, p < 0.001$ ). Regarding other EBP skills, we did not find an association between the level of EBP exposure and the barrier "lack of searching skills" ( $r = -0.006, p < 0.399$ ) and "lack of knowledge in scientific methods" ( $r = -0.05, p < 0.520$ ) (Paper I). Most importantly, we did not find an association between EBP exposure and students' use of research evidence in clinical settings ( $r = 0.13, p = 0.086$ ). Thus, our results indicate that EBP integrated across the curriculum is not sufficient to ensure use of EBP during clinical education.

Few other studies have examined the relationship between the amounts of teaching and self-reported knowledge, attitudes and behaviour [170, 171]. McEvoy et al. [171] found that self-reported knowledge, attitudes and behaviours varied with EBP exposure, and improved when students received more than 20 hours formal EBP training. However, in this study [171] details concerning the type of the EBP exposure is not provided, which makes it difficult to use the results to inform future EBP curriculums. It is clear that evidence is lacking with regard to optimal strategies for EBP exposure throughout the curriculum, regarding content, timing, amount and type of training.

Previous research clearly indicates that stand-alone EBP courses in academic settings are not sufficient to improve students' competence [85, 105]. We know that EBP teaching in undergraduate education should be clinically integrated, interactive and include assessment [106], which is also in line with the central tenets of sociocultural learning theories [119]. A planned new review [214] of undergraduate education will hopefully provide even more updated knowledge on the tools used to assess EBP competence and the effectiveness of teaching strategies including interventions that are conducted across different year levels.

To develop EBP teaching and to ensure the integration of EBP in clinical education we need to know the current practice of EBP curricula, and to compare this practice to what is expected, for example by using frameworks of learning outcomes such as Kirkpatrick's levels or Bloom's taxonomy. Melnyk and Fineout-Overholt [215, p. 323-324] suggest using Bloom's taxonomy to develop a matrix that identifies EBP outcomes and course objectives. A matrix like this can assist the development of a curriculum where EBP is sequenced logically, considering the depth and breadth of the content. Several recent surveys have been conducted to describe EBP curricula [11-17, 78]. However, only one study [78] from South-Africa, Stellenbosch University (SU), systematically reviewed all documents of health science EBP curricula at SU. As recommended [74, 75], Rohwer et al. [78] used Bloom's taxonomy [77] to extract data on learning outcomes, in addition to conducting interviews with students and lectures. In this way they were able to thoroughly assess the learned and taught EBP curricula.

Potentially, this type of knowledge will be useful to develop EBP curricula in the future and it will be more feasible to test and compare different strategies for EBP exposure throughout the curriculum with regard to content, timing, amount and type of training.

To develop EBP teaching and to ensure the integration of EBP in clinical education we also need to look to educational research to ensure EBP education itself is evidence-based, for instance use of innovative and potentially effective teaching methods such as team-based learning and active learning [216, 217]. Not to mention the opportunities of connecting with students through various social networking sites such as Facebook and Twitter [215, p. 302]. Educators can use these sites to create innovative teaching and learning and to communicate with students.

### *It is essential that CIs have EBP competence*

Students in the cross-sectional survey (Paper I) reported of lack of an EBP culture as a barrier towards EBP, and students in the interpretive descriptive study (Paper II) noticed a lack of an EBP culture. Several previous studies have identified lack of support from clinical instructors as a barrier towards EBP [111, 115-117, 186, 218, 219]. This is critical. Considering the lack of EBP knowledge and skills among students, support from their mentor or CI at the clinical placement becomes even more essential. CIs have the expertise that students have not yet developed. As experienced clinicians they have the competence to evaluate the clinical relevance of research evidence, and can therefore help students to bridge the gap between theoretical and practical knowledge [128]. Undoubtedly, CIs are important for students' learning during clinical education [133, p. 160], and we need to ensure that students meet CIs that also can role model EBP. However, results from our qualitative study (Paper II) and from several other studies indicate that students lack role models with strong skills in EBP, in particular among their CIs [111, 115-117, 130]. In line with previous studies [220-222], CIs in our study (Paper II) recognized that they need training in EBP to ensure EBP in clinical education.

The training program in EBP among CIs was successful in improving EBP knowledge, skills and beliefs (Paper III). One explanation for this success is that the intervention was multifaceted, clinically integrated and included assessment, in line with the conclusions by Young et al. [106], and held a socio-cultural perspective on learning [124, 125]. Socio-cultural learning theories support that learning takes place in authentic settings (clinically integrated) and through social interaction (interactive)

In our study, the intervention was not successful with regard to EBP behaviour, and changes achieved at post-intervention were not sustained at six-month follow-up. It is important to ensure such long term changes among CIs, because EBP competence and behaviour among CIs can enhance students learning experience in clinical placements [223]. Perhaps CIs in our study (Paper III) found it more difficult to practice evidence-based when they were left alone after the intervention was finished, and they no longer received any support. During this period they might have experienced frequently reported barriers among physiotherapists, such as lack of time, inability to understand statistics, lack of support from employer, lack of resources, lack of interest, and lack of generalisation of results [205]. To overcome such barriers, CIs within athletic training suggest better integration of the classroom and clinical experience, in addition to better collaborative efforts within the clinical and academic program [224]. This sounds like common-sense, and corresponds to findings from our interpretive descriptive study (Paper II) where CIs emphasized that they needed more information concerning how they could contribute to ensure EBP among students.

When considering the results in two of our studies (Papers I and II), it should be noted that students were not required to apply EBP in clinical situations, except for in written assignments. In particular, the lack of assessment of EBP behaviour could explain the low correlation between the different levels of EBP exposure and EBP behaviours, abilities and barriers for most items (Paper I). Without clear assessment criteria and expectations of students, we can perhaps not expect that students practice evidence-based, or that their CIs require EBP from students. Clear criteria could also guide CIs in their supervision of students. As pointed out by Young et al. [106], assessment is a central element when it comes to influencing the effect of EBP teaching. A recent US

study has focused on developing specific criteria for how to evaluate nursing students' performance during clinical placements [225]. These criteria need to be transferred and tested in other settings. Furthermore, we need to create opportunities for students to implement EBP during clinical placements (e.g. run journal clubs, small research projects). Such efforts are in line with international and national strategies [24, 60].

Some authors [226, 227] suggest a combination of empowering both CIs and students to ensure EBP is central to clinical education. Allowing for meaningful collaboration between CIs and students may potentially promote positive attitudes towards EBP among clinicians and CIs that students meet during clinical placements. Students, CIs and teachers will need to speak "the same language" if we are to succeed with embedding EBP in clinical education. When both students and CIs have EBP competence, there is more room for dialogue. For example, students and CIs can more easily discuss the applicability of research evidence in real patient situations when they both see the relevance of applying research evidence, and when they both have the skills to evaluate that research evidence [228].

The impact of teaching EBP to CIs has been addressed only in a small number of uncontrolled before-and after studies [229-231]. Knowledge and attitudes, but not behaviour were assessed in these studies, and findings of improved knowledge and attitudes have to be interpreted with caution due to methodological deficits. A timely question to ask is why CI should be specifically addressed in EBP teaching interventions, and whether and how they are different from other clinicians. CIs are perhaps not different compared to their clinical peers. However, Upton et al. [232] compared EBP profiles of academic and clinical staff within nursing education, and found that clinical staff scored lower on knowledge and skills. Accordingly, clinical staff may need extra support. Although academic staffs have EBP competence, there may be a knowledge gap in EBP teaching strategies [233]. Efforts are needed that everyone involved in EBP education have the necessary competence. Considering how important CIs are for students learning, it is in particularly essential that this group have EBP competence. Perhaps it is also necessary to assess whether EBP competence among CIs makes a difference, to their students' behaviour.

## **7. Conclusions and implications**

This study has contributed to our understanding and knowledge of how to ensure use of EBP in clinical physiotherapy education. We found that students at clinical placement were positive towards EBP, but they struggled to apply EBP in real patient situations. Barriers such as lack of knowledge and skills, in particularly searching and critical appraisal skills hindered EBP behaviour. There was only a weak association between the level of EBP exposure and students self-reported EBP behaviours, abilities and barriers. No association was found between the level of EBP exposure and students' self-reported use of research evidence in real patient situation. Efforts are needed to further develop educational frameworks and to explore strategies for EBP exposure throughout the curriculum, regarding content, timing, amount and type of training. Students at clinical placement attempted EBP, but as novices they struggled, leaned on their CIs, prioritized practice experience over EBP and lacked role models in EBP. CIs are in a unique position to influence students during clinical education. A multifaceted and clinically integrated training program in EBP was successful in improving EBP knowledge, skills and beliefs among CIs, but not long-term EBP behaviour.

## 8. Further research

This study has identified several unanswered questions and need for further research within EBP and clinical physiotherapy education. Some of the unanswered questions that need to be addressed are:

- What is the most valid and relevant educational framework that reflects what is expected from undergraduate students at different stages (e.g. 1<sup>st</sup> year, 2<sup>nd</sup> year and 3<sup>rd</sup> year)?
- What is the EBP content of various educations in Norway (or other countries) (a document review)?
- What criteria are valid and relevant (context specific) to evaluate use of EBP in academic settings?
- What criteria are valid and relevant (context specific) to evaluate use of EBP in clinical education?
- What valid and reliable tools exist that enable activity monitoring of students EBP behaviour during clinical education?
- What teaching strategies are needed for EBP exposure throughout the curriculum, regarding content, timing, amount and type of training (dose – response)?
- What is needed of an intervention in EBP training of clinicians to ensure long term EBP behaviour change among CIs?
- What is the feasibility and/or impact of an EBP training program on CIs from other health care professions (e.g. larger scale study with a comparison intervention)?
- What is the impact of an EBP program on CIs abilities to transfer EBP knowledge and skills to supervisory situations with their students, compared to CI who has not participated in an EBP program?
- What is the impact of EBP attitudes/beliefs, knowledge, skills and behaviour among CIs on students' EBP behaviour?



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