



Published online: 3-16-2011

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IJPBL is Published in Open Access Format through the Generous Support of the [Teaching Academy at Purdue University](#), the [School of Education at Indiana University](#), and the [Jeannine Rainbolt College of Education at the University of Oklahoma](#).

Recommended Citation

O'Donoghue, G. , McMahon, S. , Doody, C. , Smith, K. , & Cusack, T. (2011). Problem-Based Learning in Professional Entry-Level Therapy Education: A Review of Controlled Evaluation Studies. *Interdisciplinary Journal of Problem-Based Learning*, 5(1).

Available at: <https://doi.org/10.7771/1541-5015.1218>

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Problem-Based Learning in Professional Entry-Level Therapy Education: A Review of Controlled Evaluation Studies

Grainne O'Donoghue, Sinead McMahon, Catherine Doody, Kathryn Smith, Tara Cusack

Abstract

Although there has been growing interest in problem-based learning (PBL) by professional entry-level therapy educators, its effectiveness is as yet unclear. Existing overviews of the field do not provide high-quality evidence in terms of the effectiveness or otherwise of PBL in professional therapy education. The purposes of this article is to systematically review the current literature on PBL and determine its effectiveness when compared to other didactic approaches in physiotherapy, occupational therapy, speech-language therapy, dietetics, podiatry, orthoptics, and therapeutic radiography entry-level education.

Eight databases were searched for controlled evaluation studies investigating the effectiveness of PBL in the seven therapy professions. Four competencies were analyzed: students' knowledge, performance, approaches to learning, and satisfaction. Data were extracted and risk of bias assessed by independent reviewers. One scoring system was used to assess the quality of the studies and another to determine the level of evidence for each competency.

The search yielded 3885 articles, of which six met the inclusion criteria after full-text review; three in physiotherapy and one each in occupational therapy, dietetics, and podiatry. Three of the six studies were categorized as high quality. No study measured all four competencies. When compared to other didactic approaches, there is no evidence that PBL has a more positive effect on students' knowledge, performance, and satisfaction levels and limited evidence that it improves students' approaches to learning. Currently available literature revealed no convincing evidence that PBL is more effective than traditional didactic education for entry-level therapy professions.

Background

Problem-based learning (PBL) is "learning that results from the process of working towards the understanding or resolution of a problem" (Menahem & Paget, 1990). The core of PBL in clinical education is that the patient problem is presented before any theory is learned and that the students build up their knowledge base on the patient problems with which they have been presented rather than learning pathologies and treatments theoretically (Barrows & Tamblyn, 1980). Learning is student centered and focuses on development of problem-solving skills and the reasoning used by clinicians in solving patient problems (Barrows & Tamblyn, 1980).

Problem-based learning represents a major development and change in educational practice that continues to have a large impact across subjects and disciplines worldwide (Newman, 2003). It allows the education world to parallel the real world, where students encounter problems commonly experienced in practice, which provide the stimulus for independent learning (Boud & Feletti, 1991). It is promoted by professional and funding bodies, including the World Federation of Medical Education (Walton & Matthews, 1989) and the World Health Organization (1988), as an appropriate strategy for professional education and increasingly as the method of choice.

A considerable amount of attention has been given in the literature to PBL in medical education. There have been three well-known reviews published in the same year (Berkson, 1993; Albanese & Mitchell, 1993; Vernon & Blake, 1993) that have attempted to provide evidence about the conditions and contexts in which PBL is more effective than other educational strategies in medical education. Results from these reviews came to differing conclusions. Berkson (1993) concluded that the graduate of PBL is not distinguishable from his or her traditional counterpart. She reports the PBL experience can be stressful for both the student and the faculty and its implementation unrealistically costly. Albanese and Mitchell (1993), while acknowledging the weaknesses of the research literature, concluded that PBL was more nurturing and enjoyable and that PBL graduates performed as well and sometimes better on clinical examination and faculty evaluations. Similarly, Vernon and Blake (1993) concluded that the results from their review generally support the superiority of the PBL approach over more traditional didactic methods. Two more recent reviews also resulted in differing conclusions. Smits et al. (2002) reported that there was no consistent evidence that PBL is superior to other educational strategies in improving doctors' knowledge and performance, while Van Den Bossche and colleagues (2000) concluded that PBL had a positive effect on students' skills but a negative effect on their knowledge. Problematically and significantly, all reviews provide only limited descriptive information about the educational interventions that are called problem-based learning or the interventions to which PBL is compared, making direct comparison to some extent difficult.

Although PBL originated in medical education, its growing popularity in therapy education has been well documented. It has been implemented in physiotherapy (Titchen & Cole, 1991; van Langenberghe, 1988; Kaufman, Portney & Jette, 1997; Eksteen & Slabbert, 2001), occupational therapy (Busuttil, 1988; Royen, 1995; McCarron, 2002), speech-language therapy (Mok, 2009), dietetic (Terry, 2008, Lohse, Nitzke, & Ney, 2003), and podiatric (Finch, 1999) professional entry-level education. As therapists are required to problem solve in their day-to-day clinical practice, acquiring knowledge in the context of solving problems would appear to be an appropriate approach for educating entry-level students (Bransford et al., 1989). In addition, previous research has shown students in the PBL learning environment have developed stronger clinical competencies (de Vries, Schmidt, & de Graaff, 1989). A study conducted in a dietetics course found that PBL students perceived that they developed stronger thinking and problem-solving skills, more effective communication skills, and a greater sense of personal responsibility than the students that received didactic instruction (Lieux, 1996).

However, adoption of PBL has been met with some concern, primarily because of the substantial resource requirements. For example, student contact hours are greater for educators in a PBL curriculum than for educators in a traditional curriculum (Choon-Huat Koh et al., 2008). As a consequence, the economic viability of PBL is a concern. Given the limited resources available, evidence-based evaluation of the effects of PBL in therapy entry-level education is warranted.

Despite a substantial volume of literature, most articles that have been published in terms of therapy professional entry-level education focus on discussing PBL in the overall curriculum design and provide a general discussion on the methods of PBL. These articles also tend to provide descriptions of students' perceptions of the method of PBL. Existing overviews of the field do not provide high-quality evidence with which to provide support or otherwise in terms of the effectiveness of PBL. Therefore, this systematic review was conducted to help provide a comprehensive summary and synthesis of existing high-quality research and identify the areas where further primary research is needed.

Methods

Team Members

The review team consists of five members. All team members have previous experience of or training in systematic review methods.

Review Design

The design of the review used as a model the approach employed by the Cochrane Effective Practice and Organisation of Care Group and Guidelines on Systematic Reviews,

which emerged from the Campbell Collaboration methods group (EPOC, 2007). The key principles of Cochrane and Campbell reviews are that the process for identification, selection, inclusion, and synthesis is systematic and transparent.

Search Strategy

To identify relevant studies, the following educational and medical databases from the earliest available date until January 2010 were searched: the Educational Resources Information Centre (ERIC), Academic Search Premier, PsychINFO, EMBASE, Pubmed, Cinahl, Scopus, and Web of Science. The search was carried out by four members of the review team. These members are familiar with the principles of systematic reviewing and searching of bibliographic databases for this purpose.

Free text terms and controlled vocabularies, where available, were searched. Subject headings and keywords based around “problem-based learning” were combined with the various therapy professions. References of retrieved articles were searched manually to trace potentially relevant papers.

Selection

The criteria outlined in table 1 were used to select studies for inclusion in the review. Studies in which the population was professional entry-level therapy students and the educational intervention was problem-based learning, that is, the learning process in essence resembled the methods used at McMaster University (Maudsley, 1999) or the University of Maastricht (Barrows, 1986), were considered. This consists of a tutor facilitated, problem-based learning session in which small, self-directed groups start with a brainstorming session. A problem is posed that challenges their knowledge and experience. Learning goals are formulated by consensus and new information is learned by self-directed study. It ends with a group discussion and evaluation (Smits et al., 2002).

The Cochrane Effective Practice and Organisation of Care Review Group criteria for study designs were utilised (EPOC, 2007). This Cochrane group includes quasi-experimental research designs, such as controlled trials (CCT) and interrupted times series designs (ITS) in their review. These criteria, permitting the inclusion of nonrandomized controlled trials, were employed as there are very few randomized controlled trials in medical education (Choon-Huat Koh et al., 2008). Most educational research has methodological limitations because purity of curricular change and random assignment of students are rarely possible (Norman 2003; Berliner 2002). Qualitative data collected within such studies, for example, researchers observations of events, is incorporated in reporting. Studies that utilized solely qualitative approaches, were not published as a full text article, and were not in the English language were not included in the review.

Table 1. Inclusion Criteria.

POPULATION	Participants in professional entry-level education from the following disciplines: Physiotherapy, Occupational Therapy, Speech Therapy, Dietetics, Orthoptics, Podiatry and Therapeutic Radiography.
STUDY DESIGNS	Study designs include: Randomised Controlled Trials (RCT), Controlled Trials (CT), Interrupted Time Series (ITS), Controlled before and after Studies (CBA), Qualitative data collected within such studies is included. Studies that utilise solely qualitative approaches will not be included in the review.
TYPE OF INTERVENTION	The minimum inclusion criteria for interventions are based on the presence of essential PBL characteristics as identified by Barrows (1986): Tutor as a facilitator of learning Learners' responsibilities to be self-directed and self regulated in their learning Essential elements in the design of ill-structured instructional problems as the driving force for inquiry
OUTCOME MEASURES	Minimum methodological inclusion criteria across all study designs are objective measurement of: Accumulation of knowledge Improved performance Improved approach to learning Improved student satisfaction

Data Extraction

A standardized extraction form was used to extract information from the articles included in the systematic analysis. The following data was extracted: sample size and characteristics, study design, extent of PBL in the curriculum, source of control group, and control-group intervention and primary outcomes (number and type). One member of the team performed the data extraction and two other members of the team independently checked the data extracted.

Review Method of Selected Studies

Two reviewers independently assessed the quality of the studies. Because most validated tools for assessing study quality were designed for clinical interventions, there were only

two tools available to assess the quality of PBL studies (Smits et al., 2002; Choon-Huat Koh et al., 2008). Choon-Huat Koh and colleagues (2008) validity assessment was chosen because it most closely adhered to validated quality assessment instruments, such as the Scottish Intercollegiate Guidelines Network 50 instrument for cohort studies (SIGN 2007). Furthermore, all the quality indicators included in their validity tool could be applied the studies included in this review.

Ten quality criteria were employed. Each criteria was allocated a score ranging from 0-20, making a maximum possible score of 100 points. Studies with a score above the midpoint of the scoring range were considered to be of high quality (Smits et al., 2002; Choon-Huat Koh et al., 2008).

Outcome Variables

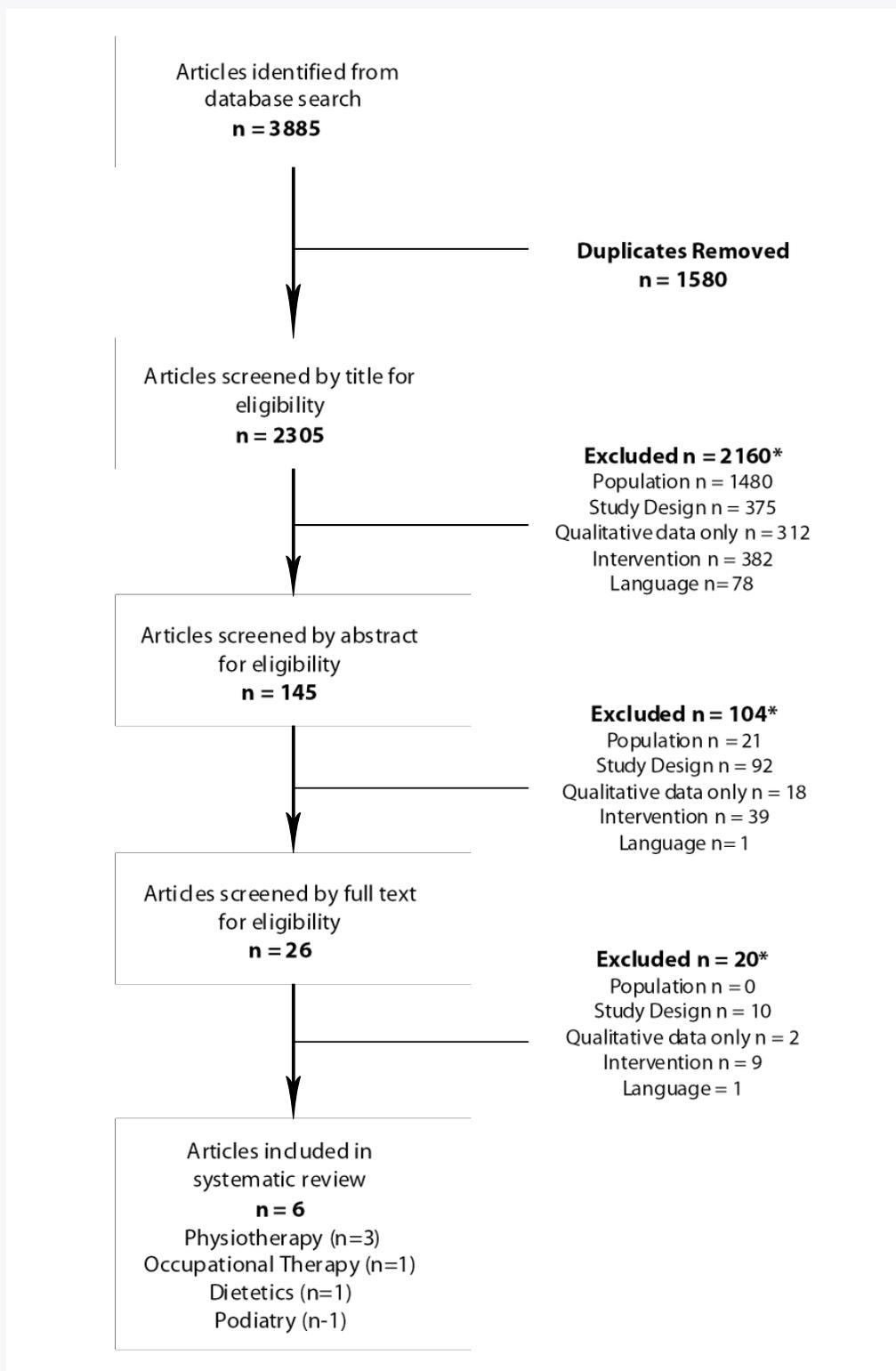
For each study, the level of evidence for four outcome variables was investigated: students' knowledge, clinical performance, approaches to learning, and satisfaction. These four variables were chosen as they closely aligned to the four general areas analyzed in the two most well-known medical education PBL reviews; student evaluation and satisfaction, academic achievement (knowledge), academic process (approached to teaching and learning) and clinical functioning (Albanese & Mitchell, 1993; Vernon & Blake, 1993).

The evidence for the effectiveness of problem-based learning was graded using the system developed by Smit et al. (2002). The level of evidence was determined based on the number of studies in support of the data, the quality of those studies, and the number of conflicting studies. Evidence was reported as strong if there was a positive outcome in two or more high-quality studies, as moderate if there was a positive outcome in one high-quality and one low-quality study, as limited if there was a positive outcome in one high-quality study or one or more low-quality studies, and none if there was a contradictory outcome.

Results

Results of Literature Search

Figure 1 illustrates the review process. Key word searches yielded 3885 potentially eligible studies. Duplicates accounted for 1580, resulting in 2305 studies for review. Initial screening by title resulted in exclusion of 2160 studies. The remaining 145 abstracts were reviewed, of which 119 were excluded. Twenty-six full-text papers were retrieved, 20 of which were excluded. The remaining six studies met the review's inclusion criteria (Finch 1999; Tichen & Cole 1991; van Duijn 2005; Liotta-Kleinfeld et al., 2001; Lohse et al., 2003; Kaufmann et al., 1997). A manual search of references from these studies did not yield any new trials that met the criteria.

Figure 1. Search and selection of studies for systematic review.

* Reasons for exclusion do not add up to total because some articles were excluded for multiple reasons.

Study Characteristics

Table 2 presents characteristics of the six studies of PBL included in the systematic analysis. The majority were in physiotherapy (Tichen et al., 1991; van Duijn, 2005; Kaufmann et al., 1997) and were conducted in the United States. There was one study included from each of the following professions: occupational therapy (Liotta-Kleinfeld et al., 2001), dietetics (Lohse et al., 2003), and podiatry (Finch 1999). No studies in orthoptics or radiography were included. Only three of the six included studies investigated an entire PBL curriculum (Finch, 1999; Tichen et al., 1991; van Duijn, 2005). The other three examined a single module (Liotta-Kleinfeld et al., 2001), two modules (Lohse et al., 2003) and multiple PBL modules (Kaufmann et al., 1997), respectively. In one study, the PBL curriculum was the control group for the assessment of another method of education (Titchen et al., 1991). One study used a randomized factorial design while the other five were controlled but not randomized. Only one study reported effect sizes (van Duijn, 2005). Table 3 shows the results of the quality assessment of the six included studies. Three studies were categorized as high quality and three as low (Choon-Huat Koh et al., 2008).

Results of Studies

Table 4 shows the results of the six studies. Study outcomes were classified according to whether the competencies of PBL students were better than (positive), the same as (no difference), or worse than (negative) those of students in the control groups, based on a significance level of .05%. One study measured three of the four outcome variables (Lohse et al., 2003), two measured two (Finch, 1999; Liotta-Kleinfeld et al., 2001) and the three remaining studies only reported results for one of the outcome variables.

Does PBL result in increased student knowledge?

Two high-quality studies and one low-quality study measured students' knowledge, the first (Finch 1999) via written examination. The Ontario Podiatric Provincial Registration Examination examined the effect of PBL on factual biomedical knowledge in podiatric students. Students in the PBL cohort achieved significantly higher overall examination scores ($p < 0.00$) than the traditional cohort.

The second study (Liotta-Kleinfeld et al., 2001), conducted in occupational therapy education revealed there was no difference in the final unit test score of the PBL group in comparison with the control group ($p = .846$). Additionally, further analysis determined that there was no significant difference on higher-level thinking between groups ($p = .491$).

The third study (Lohse et al., 2003), conducted in dietetics education measured students' knowledge via a 60-minute written course examination. Overall examination scores revealed no significant difference ($p = .643$) between the PBL and traditional curriculum groups.

Table 2. Characteristics of the six PBL studies included in the systematic analysis.

Study	Country	Profession / Qualification Awarded	Entire Curriculum / Single Module	Study Design	Participants (n)	Outcome Measures
Finch 1999	Canada	Podiatry Doctor of Podiatric Medicine (DPM)	Entire Curriculum	Controlled Trial	47	Students' knowledge via written provincial registration examinations. Approaches to learning were assessed within the examination.
Titchen et al 1991	UK and The Netherlands	Physiotherapy Diploma	Entire Curriculum	Controlled Trial	Year 1: 124 Year 2: 113	Students' approaches to learning via The Short Inventory on Approaches to Study.
van Duijn 2005	United States	Physiotherapy Not specified	Entire Curriculum	Controlled Trial	110	Students' clinical performance via the Physical Therapy Clinical Performance Instrument (CPI).
Liotta-Kleinfeld et al 2001	United States	Occupational Therapy Not specified	Single Module (Neuroscience)	Controlled Trial	43	Students' knowledge via a written examination, specifically designed for the study. Approaches to learning were assessed within the examination.
Lohse et al 2003	United States	Dietetics	Two Modules (Infant nutrition and elderly nutrition)	Randomized Block Factorial Design	32	Students' knowledge via module written examination.. Students' approaches to learning via the Cognitive Behavior Survey. Students' satisfaction using a likert scale
Kaufman et al 1997	United States	Physiotherapy Masters of Science	29 credits (Total course credits =76)	Controlled Trial	78	Students' clinical performance via the Physical Therapy Clinical Performance Instrument (CPI).

Table 3. Quality assessment of included studies evaluating effectiveness of PBL in professional entry-level therapy education.

† Scores for quality criteria

Study	Random allocation into study groups (0-15)	Total sample size (0-20)	Source of study groups (0-5)	Timing of PBL and traditional (control) curricula (0-5)	Extent of PBL in curriculum (0-5) *	Number of competencies assessed (0-10)
Finch 1999	0	0	5	0	5	0
Titchen et al 1991	0	5	0	0	5	0
Van Duijn 2005	0	5	5	5	5	0
Liotta- Keinfeld et al 2001*	0	0	5	0	0	0
Lohse et al 2003*	15	0	5	5	0	5
Kaufman et al 1997*	0	0	5	0	0	0

Study	Type of assessment (0-5)	Overall response rate (0-10)	Adjustment for co-variables (0-10)	Methodological inconsistencies (0-10)	Total Score	Quality of study †
Finch 1999	10	10	10	10	50	High
Titchen et al 1991	10	10	0	0	30	Low
Van Duijn 2005	10	10	10	10	60	High
Liotta- Keinfeld et al 2001*	10	10	0	10	35	Low
Lohse et al 2003*	5	10	10	10	65	High
Kaufman et al 1997*	10	10	10	10	45	Low

† Studies with a score at or above the midpoint of the scoring range were considered to be high quality.

* Module of PBL incorporated into traditional or mixed model curriculum.

Table 4. Results of the included studies evaluating the effectiveness of PBL in professional entry-level therapy education.

Study	Participants (Students)	Educational Intervention		Number of Participants	
		PBL	Control	PBL	Control
Finch 1999	47	PBL	Traditional	21	26
Titchen 1991*	Year 1: 124 Year 2: 113	PBL	Mixed model	25 25	99 88
Van Duijn 2005 †	110	PBL	Traditional Mixed model	20	50 40
Liotta-Kleinfeld 2001°	43	PBL	Traditional	18	25
Lohse et al 2003°	32	PBL	Traditional	32	32
Kaufman et al 1997	78	PBL	Traditional	44	34

Study	Outcome Variables (PBL versus Control)			
	Students' knowledge	Students' Clinical performance	Students' learning	Students' satisfaction
Finch 1999	Positive	NA	Positive	NA
Titchen 1991*	NA NA	NA NA	Negative Negative	NA NA
Van Duijn 2005 †	NA	No difference No difference	NA	NA
Liotta-Kleinfeld 2001°	No difference	NA	No difference	NA
Lohse et al 2003°	No difference	NA	No difference	Negative
Kaufman et al 1997	NA	No difference	NA	NA

Educational Intervention = PBL: Problem Based learning, Traditional: lectures based, Mixed model: combined small groups and lecture based NA: Not assessed.

* PBL curriculum was the control group. PBL group data from van Langenberghe (1988). Two intervention groups: Year 1 and Year 2 of physiotherapy curriculum.

† Three intervention groups: PBL, traditional lecture style, mixed model of lectures and group learning.

° One module of PBL within a traditional or mixed model curriculum.

Does PBL result in improved student clinical performance?

Two (van Duijn, 2005; Kaufmann et al., 1997) of the six studies included clinical performance as an outcome measure. Both studies measured clinical performance using the American Physical Therapy Clinical Performance Instrument (CPI). Neither study reported any difference in performance between the PBL and control groups. One high-quality study compared PBL to both a traditional curriculum and a hybrid (lectures and small group learning) curriculum in physiotherapy education (van Duijn, 2005). No statistically significant difference was found between the three curricula in terms of students' clinical performance ($p > 0.05$). The other study compared several PBL modules to traditional lecture-based modules and reported no significant difference between groups ($p > 0.05$).

Does PBL result in better approaches to learning?

Two high-quality (Finch, 1999; Lohse et al., 2003) and two low-quality studies (Titchen et al., 1991; Liotta-Kleinfeld et al., 2001) investigated the effect of PBL on students' approaches to learning. In one of the high-quality studies (Finch, 1999), PBL versus lecture based learning in podiatric education, the PBL students performed significantly better in tests of deeper understanding and cognitive skills related to patient management ($p < 0.0005$). The other high-quality study (Lohse et al., 2003), PBL versus lecture based learning in dietetics education, revealed there was no significant difference between PBL and lecture-based learning in terms of students' confidence to conduct self-directed learning and utilize problem-solving skills ($p = 0.05$).

One of the low-quality studies (Titchen et al., 1991), PBL versus subject-centered learning, found that PBL had a negative effect on student learning, while the other (Liotta-Kleinfeld et al., 2001) showed there was no difference between PBL and lecture-based learning.

Does PBL result in greater student satisfaction?

One high-quality study (Lohse et al., 2003) evaluated self-reported students' satisfaction with PBL. Compared to students in the lecture-based learning control group, PBL had a negative effect on student satisfaction. PBL students found it significantly more frustrating ($p = 0.001$) and stressful ($p = < 0.01$).

Level of Evidence

Table 5 illustrates the level of evidence for the outcome variables. Based on the results from the three studies (Finch, 1999; Lohse et al., 2003; Liotta-Kleinfeld et al., 2001) that investigated students' knowledge, there is no evidence that PBL was more effective than traditional lecture-based learning. From the two studies (Duijn, 2005; Kaufmann et al., 1997) that evaluated students' clinical performance, there is no evidence to support PBL

as a replacement for traditional learning approaches. In terms of improving students' approaches to learning, there is limited evidence to support the use of PBL. Finally, from the existing literature, there is no evidence to support or refute PBL in terms of satisfaction levels for entry-level therapy students.

Discussion

The results of this review reveal that few high-quality studies have been published examining the effectiveness of PBL in professional entry-level therapy education and the studies that are available provide very little evidence in terms of convincing measured outcome variables. Students of PBL are distinguishable from their traditional counterpart in terms of knowledge acquisition, but not in terms of clinical performance and satisfaction levels. Furthermore, only limited evidence supports PBL in improving students' approaches to learning in therapy professional entry-level education.

Although PBL methods are reportedly becoming more popular in therapy education (e.g., McCannon & Robertson, 2004; Soloman, 2005; Royeen & Salvatori, 1997; Watson & West, 1996), all meta-analyses and the majority of studies investigating its effectiveness have been published in relation to medical education. This is the first review that investigates PBL's effectiveness in professional entry-level therapy education.

Table 5. Level of evidence on outcome variables measured in studies evaluating effectiveness of PBL in professional entry-level therapy education.

	Number of High Quality Studies		Number of Low Quality Studies		Level of Evidence *
	Positive Result	Negative Result	Positive Result	Negative Result	
Problem-based learning versus other educational interventions					
Outcome Variable					
Participants' knowledge	1	1	0	1	Limited
Participants' clinical performance	0	1	0	1	None
Participants' approaches to learning	1	1	0	2	Limited
Participants' satisfaction	0	1	0	0	None

* Possible levels of evidence: strong, moderate, limited or none (see Methods for detail).

This study investigated the effectiveness of PBL on four variables; knowledge acquisition, clinical performance, approaches to learning and student satisfaction. In terms of knowledge acquisition, findings of this review are similar to those reported in several meta-analyses of entry-level medical programs: lower levels of content-specific knowledge for students in PBL programs compared with students in traditional programs were documented (Albanese & Mitchell, 1993; Vernon & Blake, 1993; Dochy, Segers, van den Bossche & Gijbels, 2003; Verhoeven, Verwijnen, Scherpbier, Holdrinet, & Oes, 1998; Antephol & Herzig, 1999). This is an area that has received considerable attention in the PBL medical literature and it has been argued persistently that PBL students have an insufficient knowledge base, particularly in the basic sciences (Solomon, 2005). This study provides preliminary evidence that therapy students respond to PBL in a similar way to medical students.

However, only three studies with small sample sizes investigated knowledge acquisition, and the heterogeneity of these data somewhat mitigates any conclusions regarding the general effect of PBL on this outcome variable across various therapy programs. In addition, the studies included in this review measured knowledge using standard measures of knowledge, including multiple-choice questions and modified essay questions. It has been argued that these traditional measures of academic achievement do not capture important differences in a student's ability to retrieve and apply acquired knowledge to real-life situations, and that other measures need to be developed to accurately evaluate knowledge acquisition in PBL (Berkson, 1993). Further studies are needed to compare therapy students of PBL programs with those from traditional programs with respect to students' knowledge acquisition.

It has been postulated that PBL students should show superior clinical performance due to the increased emphasis on clinical problem-solving and the integration of basic and clinical sciences in PBL curricula (Vernon & Blake, 1993; de Vries et al., 1989). Students' clinical performance was measured in two of the six studies reviewed. The two studies reviewed were conducted in physiotherapy and both employed a valid measure of clinical performance, the Physical Therapy Clinical Performance Instrument (CPI). Results revealed that PBL students' clinical performances were no better than those of students that participated in traditional curricula. This is a contradictory finding to that reported in the medical literature, which shows a trend that favors students in PBL with respect to clinical performance (Albanese & Mitchell, 1993; Vernon & Blake, 1993; Richards et al, 1996; Distlehorst & Robbs, 1998).

It must be noted that in interpreting the results from the Physical Therapy CPI, some of the skills measured are manual or procedural, and as problem-based learning is not expected to have a direct effect on the clinical performance of the student, it is futile to draw any robust conclusions from studies that are solely evaluated using this instrument. Since the major objective of therapy education is to prepare competent clinicians, the

question of whether students in a PBL curriculum display enhanced clinical performance when compared to the students in a traditional curriculum is of utmost importance to therapy educators. Conclusions from this study indicate further research is required in physiotherapy and other therapy professions in terms of the effect of PBL on clinical performance.

Self-directed learning has been identified in medicine as a particular strength of the PBL curriculum (Woodward & Ferrier, 1983). Proponents of PBL believe that self-directed learning skills need to and can be developed and that the context of a PBL curriculum enhances self-directed learning skills, thus maximizing the probability and quality of learning continuing once the student has graduated (Barrows, 1980). Medical literature concludes that PBL students display deeper learning behaviors, such as conceptualization and reflection, leading to the enhanced development of lifelong learning skills (Blumberg, 1992; Shin, Haynes, & Johnston, 1993). Results of this review suggest that on the basis of existing research, there are considerable gaps in knowledge about the conditions under which PBL can be expected to produce more beneficial outcomes than other strategies of teaching and learning. Available studies allow very limited conclusions to be drawn. Larger, more rigorous studies are required to thoroughly investigate the effectiveness of PBL on learning skills.

Despite the current promotion of PBL throughout professional entry-level therapy education, no study has sought to objectively compare the satisfaction levels of PBL for traditional therapy students. One study reported subjective student satisfaction rates (Lohse et al., 2003). Dietetic students found PBL to be significantly more stressful and more frustrating than traditional lecture-based learning. However, it must be noted that satisfaction scores in this study are limited in validity by their base in self-evaluation. Self-evaluations may be useful to reflect on performance but not to gauge actual outcome (Stewart, O'Halloran, Barton, Singleton, Harrigan & Spencer, 2000). Further research in the area of students' satisfaction with PBL is required before an evidence based conclusion can be drawn.

Study Limitations

This review has a number of limitations. Only three of the six included studies investigated curriculums that were PBL in their entirety (Finch, 1999; van Duijn, 2005; Titchen et al., 1991). In the remaining three studies, PBL was implemented in environments varying in scope from one single module (Liotta-Kleinfeld et al., 2001) to multiple modules (Lohse et al., 2003; Kaufman et al., 1997). According to Lohse et al. (2003), a longer period of time may be needed to overcome the surprise and concern associated with being assigned to an unfamiliar curricular format. However, while the impact of PBL as a curriculum is certainly going to be more profound, according to Albanese and Mitchell (1993), single

modules can offer a more controlled environment to examine the specific effects of PBL. Reinforcing Albanese and Mitchell's (1993) findings are the results from a meta-analysis by Dochy et al. (2003). They found no significantly different effects on achievement between a single course and a curriculum-wide implementation of PBL. Equivalent examination and clinical performance supports the need for further study with larger numbers and more time for acclimation to the instructional method to establish accurately the effectiveness of PBL in therapy education.

This review highlighted a number of conceptual, methodological, and practical problems that need to be addressed in future PBL research. The tremendous heterogeneity in the implementation of PBL has hampered efforts to evaluate and compare curriculum design.

The reporting of studies of education interventions that are labeled "PBL" by the authors does not in general appear to contain sufficient descriptions of either the experimental or control interventions. This makes it difficult to distinguish between different types of PBL and even to distinguish between PBL and other educational interventions. In part this is an issue that can be addressed by journal editors and study authors adhering to agreed guidelines in the reporting of studies (Newman, 2003).

Studying the effectiveness of education is complex (Smits et al., 2002; Norman and Schmidt, 2000) but researchers should be able to perform studies of higher quality than those reviewed here, especially when comparing educational methods. None of the included studies used a randomized controlled experimental design, only one used a randomized factorial block design, and the remaining three used a controlled design. It is difficult but possible to randomize students to different educational methods and it is essential to truly determine the effectiveness of PBL. Whereas guidelines exist for the reporting of methodological aspects of clinical study designs, no such guidelines exist for describing educational interventions. The study quality scoring system and the evaluation system of level of evidence employed in this study were not validated. They were adapted from similar assessment tools used in previous research on PBL in medical education (Smits et al., 2003; Choon-Huat Koh et al., 2008). A validated, reliable scoring system that can be utilized in all future PBL research would make study comparison more straightforward and robust. Furthermore, it would provide a reference point for educators developing a PBL module or curriculum.

Finally, with few exceptions, cultural factors and many other differences between the universities make it difficult to say which aspects of the educational setting are influential, let alone causal, in the results of the included studies. The introduction of PBL into curricula is often accompanied by other changes, such as increased emphasis on communication skills. Fully dissociating the findings associated with PBL from those attributable to other influential factors is nearly impossible (Choon-Huat Koh et al., 2008).

Conclusion

It is apparent from this review that there is a need for more research documenting the effects and effectiveness of PBL in professional entry-level therapy education. This research must be specific in terms of the intervention that is being evaluated, comprehensive in terms of the strategy employed to identify potential evidence, and methodologically rigorous in terms of the criteria used to evaluate the quality of evidence. This research is needed not only to guide PBL instruction and the development of projects, but also to provide justification for the dissemination of PBL practices within and across professional therapy education institutions.

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