



Published online: 7-31-2017

The Transfer of Problem-Based Learning Skills to Clinical Practice

Marie T. Stanton

University College Dublin, marie.stanton@ucd.ie

Suzanne Guerin

University College Dublin

Terry Barrett

University College Dublin

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

Stanton, M. T. , Guerin, S. , & Barrett, T. (2017). The Transfer of Problem-Based Learning Skills to Clinical Practice. *Interdisciplinary Journal of Problem-Based Learning*, 11(2).

Available at: <https://doi.org/10.7771/1541-5015.1678>

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.

This is an Open Access journal. This means that it uses a funding model that does not charge readers or their institutions for access. Readers may freely read, download, copy, distribute, print, search, or link to the full texts of articles. This journal is covered under the [CC BY-NC-ND license](#).

THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

SPECIAL ISSUE ON COMPETENCY ORIENTATION IN PROBLEM-BASED LEARNING

The Transfer of Problem-Based Learning Skills to Clinical Practice

Marie T. Stanton, Suzanne Guerin, and Terry Barrett (University College Dublin)

Abstract

The purpose of this article is to present and discuss the reported impact of a fully problem-based learning (PBL) master's program on the way graduates worked with patients and colleagues in Ireland. These graduates had completed a sixteen-month fully PBL master's in sonography while concurrently working in clinical practice. Semi-structured telephone interviews were used to collect qualitative data from graduates of the PBL program. PBL graduates reported four notable changes in their approach to clinical practice following the PBL MSc ultrasound program: (1) thinking more before, during, and after clinical practice; (2) more effective communication with patients; (3) improved communication with colleagues; and (4) an increase in proactivity in clinical practice. The transfer of skills developed during the PBL program, as reported by sonography graduates, led to the development of more patient-centered, evidence-based, proactive clinical practice.

Keywords: transfer, sonography, clinical skills, problem-based learning

Introduction

Sonography is a field of health sciences, which uses images produced by ultrasound energy to examine anatomy, physiology, and pathology within the body. A range of skills and knowledge are necessary to become competent in sonography. These include psychomotor, affective, and cognitive skills (CASE, 2010; Edwards, 2006). The term sonography can be used to describe examinations using ultrasound in many different contexts; however, the program researched in this study focused on developing competence in the following examinations: abdominal, gynecological, vascular, superficial structures, and obstetric ultrasound. The term sonographer is used in this paper to describe radiographers and midwives who undertake ultrasound examinations. Educational programs that develop competence to practice are essential in sonography. Sonography is considered a user-dependent imaging modality because the quality of its examinations is heavily dependent on the expertise of the sonographer (Herbst et al., 2014; Trout, Sanchez, Ladino-Torres, Pai, & Strouse, 2012). A master's program was selected for sonography education in Ireland due to this recognition

of the high level of knowledge required to practice competently in this complex and rapidly evolving field. The MSc ultrasound program is directed primarily at radiographers and midwives who wish to become competent in the theory and practice of diagnostic ultrasound.

This research was part of a wider doctoral study that investigated the impact of PBL on critical thinking. Many different conceptualizations of critical thinking exist in the literature, but none adequately defined critical thinking in sonography. Therefore, following a focused review and synthesis of the literature, an operational definition of critical thinking for the context of sonography education was created. This definition incorporated five facets of critical thinking. This paper presents research findings related to one of these: the impact of the PBL program on clinical practice. The specific research question addressed in this paper is: *Did the PBL MSc ultrasound program have a reported impact on the critical action of sonographers in the way they worked with patients and colleagues?* The other four facets were higher order thinking skills; approaches to study; ways of being; and epistemological understanding (Stanton, 2015). These will be the focus of future papers.

Literature Review

Transfer has been defined in the literature as the use of learning to solve problems in a different context to the one in which learning took place (McGinty, Radin, & Kaminski, 2013). Research on transfer has subdivided the concept into near transfer, where the new context is similar to the learning context, and far transfer, where the new context is substantially different to the learning context (Foley & Kaiser, 2013; Hung, 2013). While the aim of numerous educational programs is for students to develop knowledge and skills that will be applicable in new contexts, it is nonetheless acknowledged in the literature that transfer rarely occurs following many educational programs (Goldstone & Day, 2012).

There is a limited number of studies that focus on the impact of PBL programs on the clinical practice of participants. Connolly (2005) did report an increased client-centered approach following a PBL intervention with occupational therapists. Schmidt, Vermullen, and Van Der Molen's (2006) study of medical graduates also reported an impact on clinical practice. Here, PBL graduates reported significantly higher interpersonal skills and self-directed learning skills than non-PBL graduates. One study investigated a PBL ultrasound education module in an undergraduate radiography program (Kiguli-Malwadde, Gonzage, Businge, Nakatudde, & Bule, 2010). These researchers reported increased self-directed learning, interpersonal skills, and communication skills in their students.

The purpose of this research was to investigate the potential of a PBL curriculum to develop transferrable skills that could have an impact on clinical practice in the sonography environment. The justification for this is that sonography is a complex practice that is dependent on the skill and knowledge of the individual sonographer. There is a dearth of previous research on the impact of PBL on clinical skills related to postgraduate health science education.

Overview of the PBL MSc Ultrasound Program

The structure of the MSc ultrasound program investigated in this study fitted the fully integrated mode described by Savin-Baden (2003) and matched the closed-loop problem-based learning described by Barrows (1986) in his taxonomy of PBL. The PBL MSc ultrasound program was a full-time master's course, which included both taught and professional practice elements. Each student registered for eight PBL modules, which they completed over a sixteen-month period. Students attended the University for 16 academic blocks of three days duration during the program. Typically, students commenced a problem during one block and completed that problem the following block, as scheduled for two

to four weeks later. Every module on the MSc ultrasound program was taught through PBL. All students were employed as radiographers or midwives and performed ultrasound examinations in a clinical department between academic blocks. Central to the aims of the program was that graduates would be clinically competent at the time of graduation, and that they would have the skills to continue to develop their techniques and knowledge throughout their professional life. Professional courses have a half-life of approximately four years, according to Facione (2011). Consequently, graduates ought to have the skills to update themselves or their practice will rapidly fail to keep up with current theory and practice.

Strategies to develop generic skills aimed at lifelong learning were built into this PBL curriculum. The teaching and learning activities were centered around carefully designed multidisciplinary problems, which reflected clinical practice in sonography (Stanton & McCaffrey, 2011). Additionally, a specific PBL process guide was developed for this program (see Figure 1, next page), which the students and tutors followed for each problem they worked on. This process guide was adapted from previous guides in the literature. There are two guidelines in this model that are not present in process guides generally. First, step 6 states "synthesise critically what this means for the problem." During independent study, students were asked to synthesize the knowledge that they had developed and to relate that knowledge to the overall problem they were working on. This prompted students to synthesize their independent learning prior to the feedback tutorial. Second, step 7 includes "summarise the learning as it relates to the problem and clinical practice." This provided a stimulus to students to synthesize their independent learning with that of their peers following discussion during the feedback tutorial. This guidance was particularly appropriate to the MSc ultrasound program, as these students had significant prior learning in health sciences and an immediate clinical context to which they could apply new learning.

Students worked in small tutor facilitated groups in which the tutors were university lecturers with clinical ultrasound qualifications. PBL tutorial sessions took place in purpose-built PBL rooms within the Health Sciences Library. These PBL rooms included central tables with space for 10 people and large wall-mounted whiteboards and screens. The process included facilitated brainstorming tutorials, independent study, facilitated feedback tutorials, and resource sessions. Resource sessions were provided when students had completed a particular problem. These sessions typically consisted of an ultrasound lecturer or a clinical expert providing students with an opportunity to discuss outstanding issues and related case studies. Students' attendance at university was interspersed with experiential learning in a clinical ultrasound department. The program was assessed by a wide variety of

7 Step PBL Process Guide



© Barrett, O'Neill, Stanton and Cahman 2009. Adapted from Barrows 1989 and Schmidt 1983

Figure 1. Seven step process guide for the PBL MSc ultrasound program.

continuous assessments, including individual and group assignments, posters, clinical assessments, presentations, and reflective writing. The design of problems and assignments was integrated; for example, if a specific pathology was addressed in a problem, then a broader assignment topic was set.

Methodology

The research was guided by a pragmatic approach (Biesta & Burbules, 2003; Scheffler, 1999) and employed an action research design (Herr & Anderson, 2005; Koshy, 2010; Noffke & Somekh, 2009; Pring, 2004). The key aspects of action research, which contributed to this research design, were its theories on insider research (Bryman, 2008), improvement in education practice (Noffke & Somekh, 2009; Pring, 2004), and openness to pragmatic research methods.

Eighteen graduates of the PBL program were approached to arrange semi-structured telephone interviews using the contact details volunteered at the consent stage of the research. There were 19 students in the cohort; one was not available for an earlier phase of the research and was therefore not invited to take part in this phase. Contact was made after the students had completed and received the results of their MSc ultrasound program. Interviews were scheduled at participants' convenience. Sixteen interviews were completed with participants who had graduated from the MSc ultrasound program. An interview schedule was designed, piloted, and implemented to elicit responses to open questions related to the development of critical thinking skills. The interview schedule consisted of 33 questions; those which elicited responses related to changes in clinical practice are presented in Figure 2. The interview data were transcribed,

coded, and analyzed thematically. The details of the research methodological phases, procedures, and outputs are presented in Table 1 (next page).

Participant Profiles

The research participants were postgraduate students with primary qualifications in radiography and nursing. They were mature students aged between 23 and 45 years. The mean age was 32 years, and all participants were female. The nursing participants had additional qualifications in midwifery. All participants were already employed in medical ultrasound departments throughout Ireland. A requirement of the program was that they continued to practice sonography during their studies.

Data Analysis

The interview data were transcribed, coded, and analyzed thematically in order to investigate the impact of the PBL program on clinical practice. Following each interview, a one- to two-page contact summary sheet was completed. The structure of this sheet was based on focus questions developed by Miles and Huberman (1994) but adapted to the specific needs of the current study. The purpose of the contact summary sheet was to develop a brief overall summary of the main concepts, issues, and questions that arose during each individual interview, and to minimize the loss of important data from the interviews, which can happen in the transcription and coding phase. This process took place within a day of each interview and provided a structure to reflect on the main topics discussed (Miles & Huberman, 1994).

- Can you tell me about your experience of the problem-based learning course?
- What feelings do you have about your experience of PBL?
- How would you describe the overall influence of PBL on you as a person?
- What do you think of PBL as a way of learning ultrasound?
- What was your experience of group work on the course?
- How did other members of your group influence your learning?
- What impact if any did the course have on the way you work with colleagues?
- What impact if any did the course have on the way you work with patients?
- Have you noticed any difference in the way you practice?
- How do you think about clinical issues or problems that arise now in your clinical practice?
- How would you have thought about clinical issues before the program?
- How would you now find appropriate literature related to clinical issues you are trying to solve?
- How is that similar or different to the way you found information before the course?
- How would you judge which knowledge to apply to an ultrasound problem?
- How is that similar or different to the way you judged information before the course?

Figure 2. Questions from the interview schedule that generated responses relevant to changes in clinical practice.

Table 1. Detailed methodological phases, procedures, and outputs.

PHASE	PROCEDURE	OUTPUT
Qualitative Interviews	<ul style="list-style-type: none"> Individual semi-structured telephone interviews conducted with participants 	<ul style="list-style-type: none"> Recorded Interviews
Contact Summary Sheet	<ul style="list-style-type: none"> Completion of a case summary sheet for each interview 	<ul style="list-style-type: none"> One- to two-page contact summary sheet for each interview
Transcription	<ul style="list-style-type: none"> Transcription of interviews by third party 	<ul style="list-style-type: none"> Interview transcripts
Checking and Anonymization of Transcripts	<ul style="list-style-type: none"> Comparison of interview transcripts with the interview recordings Replacement of participant names with pseudonyms 	<ul style="list-style-type: none"> Corrected & anonymized transcripts
Development of Interview Themes and Subthemes	<ul style="list-style-type: none"> Immersion in the data Inductive detailed coding of the data 	<ul style="list-style-type: none"> Themes Subthemes Coded transcripts
Coding and Sorting of Interview Data	<ul style="list-style-type: none"> Analysis of coded data Sorting of extracts under themes and subthemes Iterative process of reviewing and organizing themes to discover links, patterns, and associations 	<ul style="list-style-type: none"> Synthesized word document containing data extracts coded by themes and subthemes
Identification of Theory	<ul style="list-style-type: none"> Consideration of interview findings with reference to application of theory to similar contexts 	<ul style="list-style-type: none"> Proposed Theory: Model of transfer of PBL skills to clinical practice (Figure 4)

The interview recordings were transcribed. The researcher checked the transcripts for accuracy by listening to the recordings while reading the transcripts. During this process, any names mentioned were replaced with pseudonyms.

The literature suggests that there are some disadvantages to transcribing interviews. For example, Mishler (1986) stated that contextual factors such as nonverbal aspects of the interview can be filtered out, and Kvale (1996) suggested that transcribed data is already interpreted data. Cohen, Manion, and Morrison (2000, p. 282) summarized the main concerns in the following extract by stating that

transcriptions are “decontextualised, abstracted from time and space, from the dynamics of the situation, from the live form and from the social, interactive, dynamic and fluid dimensions of their source, they are frozen.” The researcher had to try to maintain a balance between breaking the data down into decontextualized fragments for clarification and categorization, while also keeping in mind the meaning of the whole interview (Cohen et al., 2000). In order to minimize these effects, the researcher continued to listen to the recordings after the transcription was completed to ensure the whole interview was kept in mind, while classifying the

coded data. Repeated review of the contact summary sheets also prompted the researcher to remember the context of the coded data.

An inductive approach was used to analyze interview data related to participants' reports of changes in their clinical practice following PBL. Data on this topic were grouped together and were read and reread repeatedly by the researcher in an iterative process to develop and refine themes and subthemes (Guest, MacQueen, & Namey, 2012).

Following coding and sorting, the data were examined to see how a concept was viewed across interviews. This included looking for similarities and differences between interviewees and groups of interviewees (Rubin & Rubin, 2005).

Findings

This section analyzes interview data that contributed to investigating interviewees' opinions on what impact problem-based learning had on their clinical practice. During an analysis of these data, a number of inductive themes emerged, which are discussed here. These themes relate to the impact of problem-based learning on participants' clinical practice with reference to changes in their thinking, communication,

and actions. Figure 3 presents the themes and subthemes that were developed inductively from the interview data. Each theme and its subthemes will be discussed in this section.

Changes in Clinical Practice Related to Thinking

Participants frequently referred to changes in their ways of thinking related to their clinical practice. These comments referred to *thinking more before, during, and after clinical work*. The following extract illustrates increased thinking before clinical action:

I'd probably think more. I know that sounds bizarre but as in I'd probably more stop and think about things before rushing off doing something, or before bringing the doctor in to see something, I just find I'd be thinking just to stop and think more. (Intw 11, p. 11)

A further extract provides an example of increased thinking during clinical action:

You would try not to think in a closed box. So if you're . . . querying artery stenosis or something, you would always try, okay, we're looking for that but you are having a broad spectrum, what else could be going on?

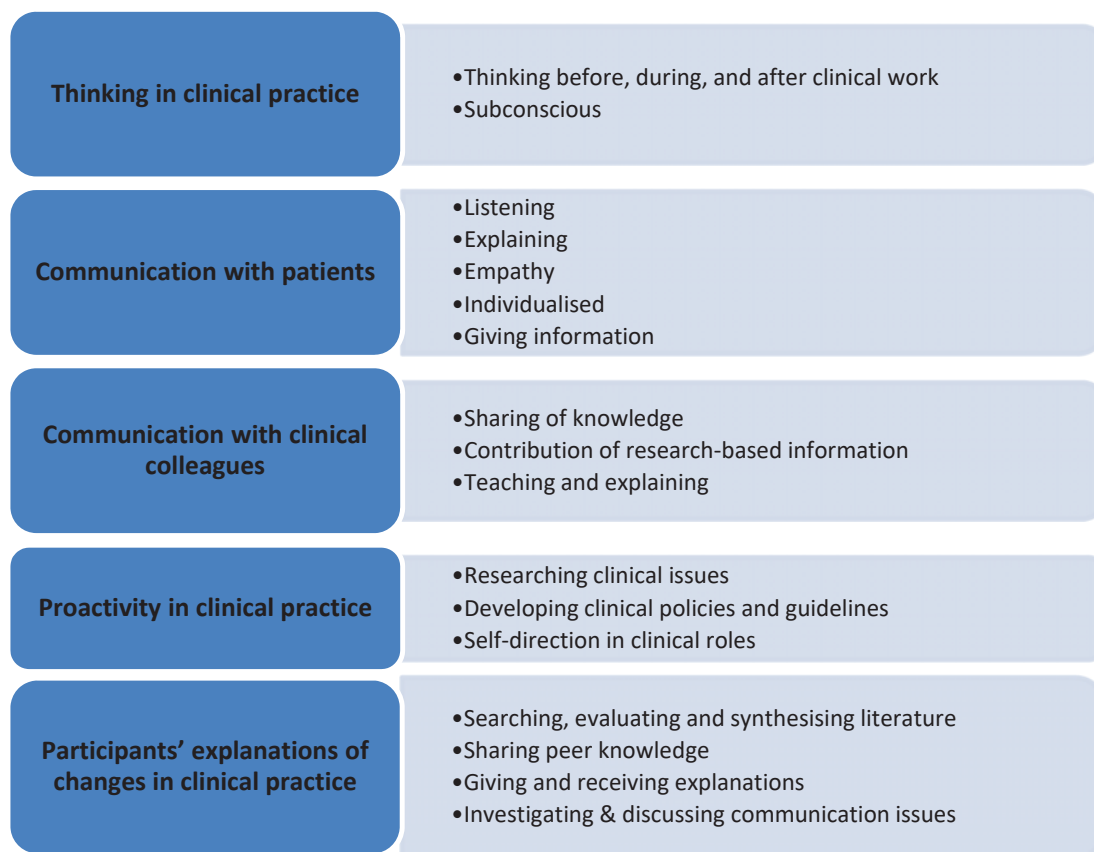


Figure 3. Themes and sub-themes: Changes in clinical practice.

Like what symptoms does this patient have? What else have I learned about it? So you're trying to rule out different differential diagnos[e]s as well and look at scans with a broad mind. (Intw 9, p. 10)

The next extract exemplifies comments related to reflecting on an experience in order to improve practice for future patients:

understand the importance of reflection on what had happened earlier in the day . . . what happened during a particular patient and learn from it for the future patients. (Intw 10, p8)

Several interviewees indicated that following PBL changes in their thinking skills had become so ingrained that they used them both *subconsciously and consciously* in their clinical work. The following extract discusses this in a general way:

the way we worked through all the problems together and discussed all the different diagnoses. I suppose I would probably do that myself in my own head subconsciously now whenever I see something. (Intw 10, p. 8)

A further extract provides more detail on the type of subconscious thinking another participant uses in clinical practice:

Subconsciously I suppose I analyse things whether and quite consciously sometimes I think if you're faced with a problem, and I suppose the work that I do now brings a lot of problems every day, and you have to just take a step back and critically evaluate it and say, Okay! If I decide to do this, what impact will that have? If I don't decide to do it what impact will that have? Or if I do something else and I would find that I would maybe look to past experiences, or try and read maybe if it was a big problem, or get advice. So by listening to others . . . I've practically brought a lot of the skills that I learned during the PBL back to my workplace and use them and, like I said, even sometimes probably subconsciously (Intw 15, p. 15).

Communication with Patients in Clinical Practice

Many participants stated that the problem-based learning process changed the way they communicated in clinical practice. These included alterations in the ways they interacted with patients and clinical colleagues. This section focuses on *communication with patients*. Participants described a change to more careful listening and in taking more care in the manner with which they explained medical issues to their patients.

The participant in the following extract refers also to improvements in her attention to *listening and explaining* to patients. She attributes these changes to repeated opportunities to work on communication issues raised in the PBL problems:

It's definitely made me more attentive to them [patients], made me listen to them more and made me explain procedures to them more. And we had problems on it, in every problem I think there was a communication aspect. So even if you were repeating yourself in some problems you had to constantly think of it for 18 months. (Intw 2, p. 13)

A second change in style of communication with patients was evident in comments that referred to the use of *empathy*. The following extract illustrates this post-PBL change and suggests that group discussions helped to improve communication skills:

Maybe I dealt with patients, probably a bit more empathetically, I suppose would be the word because when you're reading things a lot, when you're learning things and you're taking them all from a book, it's not very realistic, you actually have to deal with a lady lying on the bed there and you're telling the lady that 'Oh yes your baby has a serious problem' and you do put yourself in their shoes and it makes you think God how would I feel if that was me so you definitely deal with them . . . you have more confidence and it definitely improves your knowledge. The problem based learning definitely improved my knowledge of a lot of topics that I would have been not that well informed about. It improved. Just even to speak to the girls in the problem based learning to say 'Look, how do you break bad news?' or when we talked amongst ourselves and learned topics it was easier, it was good to be able to say 'Look, how do you do that so if it ever happens to me I'll know' and it definitely has improved my communication skills with the ladies. (Intw 13, p. 11)

Several participants talked about being more holistic in their view of patients and in having improved their ability to recognize the different needs patients may have. The following extract is one such example:

You look at the person as a whole when they come into a room. They are not just there for whatever, ultrasound. You can understand by their demeanour and their way, what sort of mood they're in and you can adapt the situation as you are going along . . . some people want a lot of information, some people won't. You know . . . that you can understand them maybe a bit more than prior to doing the course. (Intw 6, p. 7)

A further subtheme in this section arose from comments that described a change in participants' abilities to impart *information to patients*. This first extract illustrates improvements both in the way the participant speaks to patients and in the quality of the information she conveys:

I think I can give patients more information and especially with regards to the machine, the settings of the machine, I can get a more optimised image and therefore, the patient is getting better care and more diagnostic care. I definitely am getting better images and I'd be happier with the way that I scan, that I'm doing it in a better way not only with the images I'm getting but with the way that I speak to patients and the information that I can give, I can give better facts and figures as well to patients. . . . it's definitely empowered and encouraged me in my job. (Intw 12, pp. 7–8)

Communication with Colleagues in Clinical Practice

It is important to point out that ramifications occurred beyond individual students in the program, also impacting groups of their colleagues in clinical practice. With reference to modifications in communication with clinical colleagues, interviewees described increased *sharing of knowledge* through discussion; increased *contribution of research-based information* to resolve clinical disagreements; and increased interest in *teaching and explaining* ultrasound to colleagues and students. Two extracts demonstrate the development of habits of bringing and sharing information and research with clinical colleagues. The first of these illustrates a change to sharing information obtained through the PBL program with clinical colleagues:

I think it encouraged me to give more information to my colleagues; it developed learning among the unit I was working in as well because I was bringing back the information that I had learned and was giving it to people that hadn't attended the course and definitely the level of learning within the unit had developed as well. (Intw 12, p. 7)

Sharing information with colleagues continued after the PBL program. The following extract illustrates this continued discussion of clinical cases:

I'm much more likely to have a discussion on cases now and give feedback so I feel, I think the course has influenced me in that. I may have looked up something myself in the past, but I may not necessarily have shared it around, I feel I have a licence now to say well

look, look at this, this interesting case and this is the background to it, so yes it has a positive influence, positive impact. (Intw 5, p. 8)

The following comment illustrates the development of *listening* skills, but also confidence in speaking out and using the literature to support a particular stance on clinical issues:

If I'm in a discussion with people now or we can listen to their opinion rather than jumping in and voicing mine straight away. I'd listen more . . . I'd be more tolerant with people. I would also be more confident in speaking my mind or if there was any meetings going on, if I have an opinion or because I have knowledge base as well from studying, I'm not afraid to stand up and be counted for and I can argue my point more efficiently. I can say well this is the latest research I got, when we're discussing a topic, I can go off and look it up. I know how to research now and I know where is the latest information, where I can find it, so I can argue my point amongst the best now. (Intw 6, p. 5)

The final comment in this section highlights the increased involvement participants had in *teaching and explaining* ultrasound to students and colleagues. An increased interest and motivation to teach in the clinical environment is illustrated here:

I would tend to want to teach more, if I find something interesting I would always try and teach, inform my colleagues and say look I have this article about something . . . say for example congenital heart or probably something like that and . . . whatever information I have learned I would be interested in giving that information to them as well, so see from working perhaps sometimes you can be so focused on just getting through your list of cases for the day that you mightn't think to do that, so I suppose as a result of doing the course . . . I'm more interested in learning myself and then in teaching and imparting my information to my colleagues. (Intw 14, p6)

Proactivity in Clinical Practice

This section analyzes the data related to proactivity in clinical practice. Subthemes were developed from the data related to participants' increased interest in: *researching issues arising in clinical practice*; *developing clinical policies and guidelines*; and *being more self-directed in their clinical roles*. Most participants described a change from being passive to being more proactive in their clinical practice. This increased proactivity is illustrated in each of the subthemes discussed in this section.

Participants often discussed an increased interest in *researching issues arising in clinical practice*. The following extract illustrates a change in this regard:

If there's things that I come across, before I would maybe just run down to the radiologists and just say what's that or whatever. Whereas now I'd go and look it up in the books myself or look up some of the articles. Before I used [to] never, as I say, look at articles. (Intw 4, p. 15)

Participants discussed being more persistent in their efforts to research issues arising in clinical practice, as illustrated in the following extract:

And I think now when I see something new, even after the patient goes, I'm inclined to Google it or look it up in a book. And then if I can't get my answer from there I'll go home and look it up or I'll go into a [registrar] and go through the images and discuss it with them or one of the consultants. So definitely more interested . . . in the appearances and the reasons for them, or the causes, the prognosis, things like that. (Intw 2, p. 15)

Participants reported increased motivation to look up clinical issues for themselves and the development of their confidence to deal with future clinical problems:

I have become more motivated in seeing different things that you need to go and read up around, rather than just seeing them on the day and then just leaving it. You want to achieve better results for the patient, and if you saw the scenario again or the clinical issue again, that you would be able to deal with it confidently yourself. (Intw 3, p. 7)

Proactivity is also evident in participants' descriptions of how they *developed clinical guidelines and policies*. In the following extract, the participant compares her approach to developing policies before and after PBL:

We had to develop policies in work and I would have used it [PBL] because it would have influenced the way I did the policies, after the course compared to if I had to do policies prior to the course. Instead of fluffing things up and rambling around things, I got straight to the points and succinct points and more developed, and used a lot more range of resources available to me. (Intw 8, p. 3)

Participants reported a tendency to consult the literature in a more systematic way when looking for guidance on clinical practice. The following extract emphasizes this as the participant discusses her change in approach to *researching issues*:

At work at the moment we're trying to do guidelines and trying to keep them . . . in line with what's happening internationally rather than just assuming this

should be just an in-house guideline. . . . You know backing up what you're finding really. I would think making more of an effort . . . I now know the information is there and the facilities are there, that would be the other thing, that would be a huge thing, and that. Yeah that would be it. How would I have done it before? I suppose being honest I probably wouldn't have done a lot. (Intw 16, p. 17)

Participants discussed their literature reviews post-PBL in a manner that emphasized a more methodical approach, as illustrated in the following extract related to reviewing the literature on optimizing ultrasound imaging in obese patients:

I'm doing a literature review at the moment about obesity and ultrasound and trying to . . . how do you optimise your machine to get the images that you want, more specifically to anomaly scans so I find it a lot easier to read articles and books so I know where I'm heading to rather than just reading through all these different articles and not really knowing exactly what you want to achieve at the end. So I suppose you're a lot more methodical about your approach to learning (Intw 14, p. 3–4).

The final subtheme in this section relates to changes in participants' *self-direction* in their clinical roles. Many participants described their handling of clinical issues following PBL in terms that inferred increased self-direction in their approach. In the following extract, the participant discusses using her own initiative to improve the service she offered to patients:

making decisions a little bit more for yourself . . . in ultrasound, if you find something in . . . an adnexa or something like that when you were doing an abdomen scan, again having the confidence to just go ahead and get the best images for the patient rather than leaving it and getting them re-called or whatever, maybe in that way it pushes you a little bit more, pushing yourself a bit more. (Intw 7, p. 8)

A further example of increased self-direction illustrates the participant's use of PBL skills to cope with the lack of teaching time in clinical practice:

I'm trying to find it out myself, it's I suppose with units being so busy and the health service the way it is there's very little time for teaching really it's just a case of having to find out for yourself. . . . So probably using the same problem based . . . skills I learnt during that course and not waiting for someone else to come and just tell me that's how it is that's how it's being done. (Intw 16, p. 4)

To conclude this section on *proactivity in clinical practice*, the following two extracts illustrate one participant's change from a passive role in her clinical work to a proactive interest in making changes, finding information, and being more self-directed. The first extract starts with her talking about her response to clinical issues before the PBL program:

I might have taken a back seat to tell you nothing but the truth. If there was a problem I might refer it to my managers or the clinical midwife specialist, I didn't think it was my job to be influencing it but it has definitely changed during the course I have become an awful lot more proactive (Intw 12, p. 9).

This change to becoming more proactive can be discerned in the next extract from the same interview. In reflecting on clinical issues after the PBL program, she suggests that:

If an issue comes up now . . . I'd be more proactive. Recently I've changed jobs and I'd be confident to go to people and say 'Right this needs to be changed and that needs to be changed and we need to get information about this and we need to get information about that.' It would definitely make you stronger at work and make sure that everything is in place and that you'd go and find it, you wouldn't necessarily be looking for other people to get it. (Intw 12, p. 9)

Participants' Explanations of Why They Think PBL Changed Their Clinical Practice

Thematic analysis of the data led to insights related to participant's opinions on why PBL had changed their clinical practice. This section addresses four explanations reported by participants.

First, there was evidence of transfer of the experience of seeking and sharing knowledge during independent study and feedback tutorials to seeking and sharing knowledge in the clinical environment. Participants continued to actively seek and share knowledge related to their clinical practice after the PBL program, as illustrated in the following extract:

I would always try and feedback anything that I've heard or read or been advised by someone else to colleagues, and hopefully help their learning because of it, and I think it has made me want to continue on obviously and do more ultrasound training. I would actively read journal articles and things now and papers just to keep my knowledge up and because I'm interested in it. I think during the course because you did so much self-taught learning and reading, you wanted to keep that up. So I think then sharing that knowledge with colleagues is

something that I want to do and I think it's probably based on the feedback session. You get used to that and you get good feedback and build a team morale and momentum and it motivates the others to do the same. So I think that's how it has impacted. (Intw 15, p. 9)

Second, participants had opportunities to develop positive attitudes toward the sharing of knowledge through the PBL feedback sessions. In the following extract, the participant attributes the enthusiastic sharing of information during feedback sessions to the lack of formal assessment of this group work:

I think the fact that PBL, the PBL sessions themselves, weren't marked, so that you went and you got all of this information and you shared it with your colleagues and to see the enthusiasm for information in a room even though it's not been marked, I thought that was very encouraging and it definitely developed my like and love for learning. (Intw 12, p. 13)

Third, participants reported that explaining concepts during PBL tutorials developed their abilities and confidence to explain concepts to colleagues in clinical practice. The following extract illustrates the transfer of PBL skills developed during the program to explain ultrasound concepts to less-experienced sonographers:

In the PBL groups and there's a certain amount of everybody teaches each other something else, and what I learned you may not have learned, so you almost teach the other person what you know, and pass it on that way and certainly with working with other colleagues who have only started the course or who are behind me in their ultrasound training it definitely helped in that if they're not getting their head around something maybe the skills that we've developed in doing the problems help in trying to go about explaining something to them or helping them get their heads around it. (Intw 7, p. 7)

Furthermore, the development of communication skills in clinical teams was attributed to the practice participants got in interacting during PBL group tutorials:

[PBL] has given me a lot of, maybe, insight as to how teams should work and the things that can go wrong in them and how you have to try and overcome that problem. (Intw 7, p. 4)

Fourth, participants reported that their communication skills with patients improved due to the fact that many problems included a communication issue related to interactions with patients:

Yes, I think just the research into communication . . . most problems that you looked at, the importance of listening and how a lot of the time the patients are able to tell you a lot more than if you just read the referral note, by listening to them you can gain a lot more insight into things, maybe what the root of the problem might be, why they're here. (Intw 15, p. 10)

In summary, interviewees credited improvements in their clinical practice to the following aspects of PBL:

- repeated opportunities to search, evaluate and synthesize literature;
- the transfer of learning to share knowledge during PBL to the sharing of knowledge with clinical colleagues;
- learning to explain issues to fellow students led to teaching clinical colleagues;
- interaction in students PBL groups led to more communication in the clinical context; and
- the inclusion of a communication issue in most PBL problems highlighted theory and practice of this to students.

Figure 4 (next page) synthesizes the findings related to participants' opinions on why PBL changed their clinical practice.

Discussion

Interviewees' discussions of *changes in their clinical practice* following the PBL program indicated that they transferred PBL skills from the academic context to their clinical workplace. Skills transferred included being more interested in patients and communicating at a higher level with patients and colleagues. Furthermore, graduates discussed their post-PBL practice in ways that indicated that they had become more proactive in their clinical roles.

There was evidence that students transferred PBL skills from the academic environment when addressing specific problems in clinical practice due to similarities between the PBL scenarios and their clinical practice contexts. This is known as near transfer (Foley & Kaiser, 2013). In near transfer there is direct application of previously learned knowledge in a context that is very similar to the original context (Hung, 2013). However, there was also evidence that participants transferred critical thinking skills from the academic environment to clinical practice contexts that were substantially different to the original PBL scenario contexts. This is known as far transfer (Foley & Kaiser, 2013). Far transfer is associated with higher level cognitive processes, as the learner has to modify the original knowledge in order to use it effectively in the new context (Hung, 2013). The PBL process employed in this study has features in common with recommended

strategies to maximize transfer of learning to new contexts. First, the fully PBL MSc ultrasound program provided an opportunity for students to work on many problems providing multiple experiences of concepts in multiple contexts. This use of many problems provides variability in conceptual and contextual dimensions of knowledge, and it is recommended to maximize transfer of learning to new contexts (Kulasegaram et al., 2015). Second, the PBL MSc ultrasound program encouraged students to identify underlying principles and deep structure of topics rather than superficial facts. This focus on deep structure is associated with maximizing transfer of learning by Diemers, van de Wiel, Scherpbier, Baarveld, and Dolmans (2015), Norman (2009), and Patel, Yoskowitz, Arocha, and Shortliffe (2009). The findings of the current study related to the transfer of learning between the academic and clinical contexts are therefore supported in the extant literature.

This research contributes a model of sonography education reported by graduates as having had a number of important impacts on their clinical practice. Increased proactivity in clinical practice is an important change identified by graduates following the PBL program. This increased proactivity included recognizing, investigating, and acting on clinical issues with due regard to evidence-based literature and discussion with colleagues and relevant experts. In recent years, a number of high profile failures in the use of imaging in healthcare have been reported and investigated in Ireland (Doherty, 2008; HSE, 2011). Proactive health care professionals could have prevented or reduced the impact of poor clinical practices in these situations. For example, the HSE (2011) National Miscarriage Misdiagnosis Review identified problems with the quality of ultrasound equipment in use; the lack of appropriate education of doctors; and nonadherence to internationally recognized protocols in the misdiagnosis of miscarriages in Ireland over an extended period of time. This scenario impacted on a large number of women who had miscarriages diagnosed and were left wondering if they had in fact got the correct diagnosis. It is likely that other groups of healthcare professionals had at least some suspicions that there would be consequences in a situation where doctors unqualified in performing ultrasound examinations were provided with sub-optimal equipment to perform these high stakes examinations, and often without appropriate protocols. This issue came to light only when a patient told her story to the media, rather than from any health care professional having the knowledge, confidence, or courage to investigate concerns that it is possible to surmise that at least some personnel may have had. This issue of misdiagnosis in ultrasound imaging is of international concern (Al-Memar, Kirk, & Bourne, 2015; Shavell et al., 2012; Solomon & Saldana, 2014; Tan, Waugh, Kumar, & Evans, 2013).

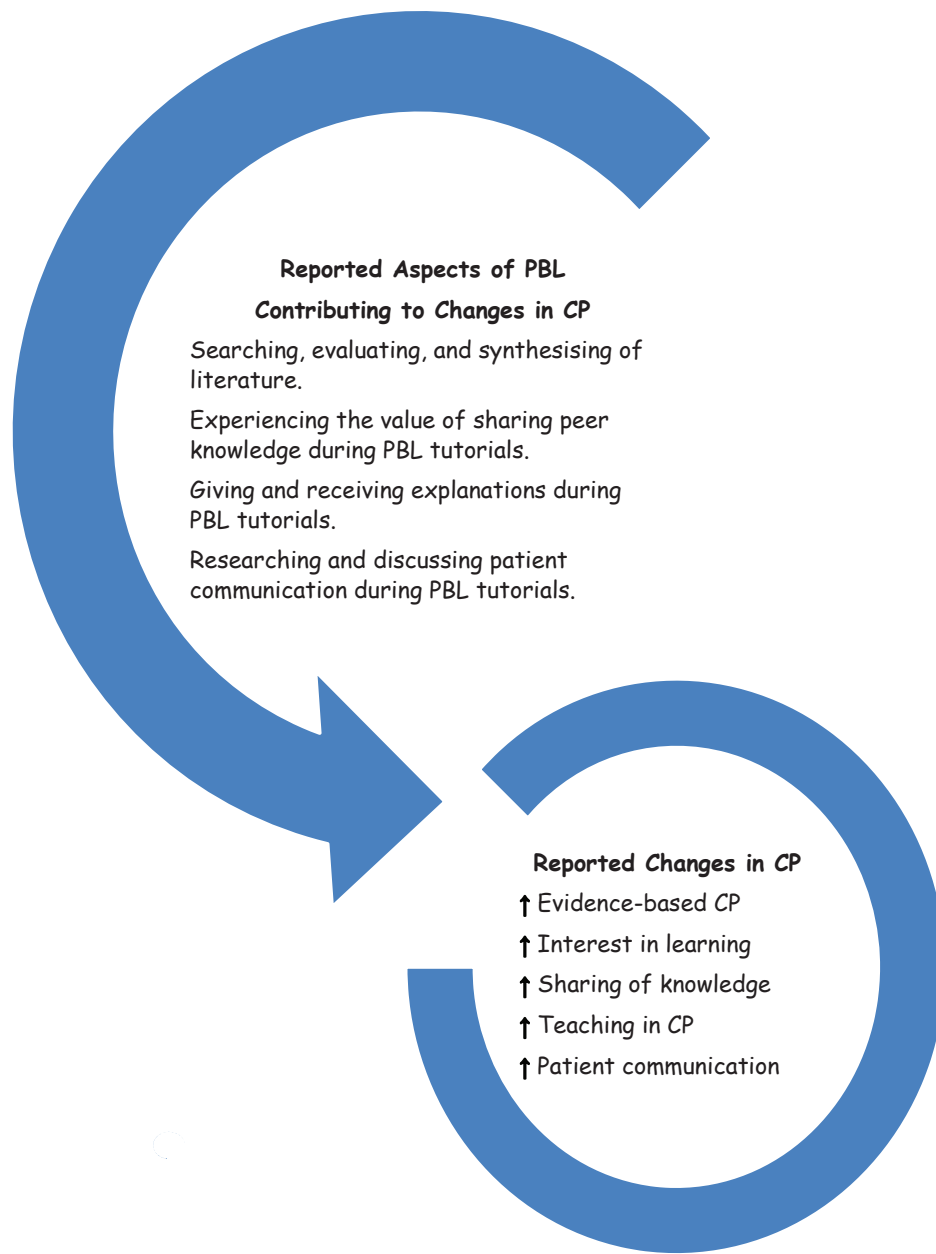


Figure 4. Transfer of PBL skills to clinical practice (CP).

A further contribution to clinical practice is the improvements in communication skills reported by the PBL participants. An improvement in communication with patients was associated with more relaxed interactions with patients and improvements in providing coherent, evidence-based information to patients and answering their questions. The importance of this contribution is highlighted by the Irish Health Service Executive's Report (2014), which documented 3,517 communication and information failures as the most common reason for patient complaints to the executive. This category of complaints constituted 42% of all complaints in 2014.

Reported improvements in communication with colleagues in the current study have the potential to improve clinical practice due to increased interest in sharing evidence-based knowledge, protocols, and practices with colleagues. Increased discussions with colleagues led to ongoing negotiations regarding best practices. The importance of such changes are highlighted by their potential to ameliorate the large number of complaints to the HSE related to "safe and effective care." At 2,520 (30% of all complaints), this was the second most common reason for complaints to the HSE in 2014.

Limitations and Further Research

The role of the insider researcher in this study posed some issues (Punch & Oancea, 2014; Zeni, 2009). The researcher was cognizant of her potential to influence the outcome of the research at multiple points. Submitting to a detailed ethical approval process guarded against some of the dangers of students feeling pressured into taking part in the study and into answering in a predetermined way. At the time of the research, the researcher was the course director and had been the main driver for changing the program to a PBL model. The researcher's awareness of these issues as potential sources of bias helped to guard against a biased approach. Regular discussions with research supervisors and regular presentation of the work at conferences and to a peer-writing group provided further safeguards against the development of preconceived outcomes.

A limitation of the current research is that the cohort of sonography students studied in this research is relatively uncommon, which limits the potential to generalize from the findings. However, it does have similarities with other postgraduate programs in health sciences, particularly those where students work in a health service, while concurrently registered for a postgraduate academic program. Program directors and researchers can analyze the description of the researched curriculum and make their own decisions regarding the applicability of this research to their context.

As the cohort of students included in the study were all female, the use of a similar curriculum with cohorts that are mixed or all male cannot be assumed to deliver the same outcomes. This limitation is alleviated by the fact that the gender of sonographers together with many other health science professions is predominantly female (Eliason, 2014; Roska, 2005; Shen-Miller & Smiler, 2015).

The research relied predominantly on self-report interviews. This may have led to participants trying to please the interviewer (Rubin & Rubin, 2005), given their role in the program. However, the depth of respondents' answers and the detailed examples they provided of changes in their clinical practice provide support for the credibility of this data. Participants did criticize some aspects of the program, thus demonstrating that they felt free to discuss both positive and negative experiences of the PBL program. At the time of the interviews, all participants had completed their program and had received their results, so they were more likely to feel able to criticize the PBL program.

Further research should investigate the findings in relation to the transfer of learning from academic to clinical environments. These findings are particularly important due to the lack of evidence of transfer in many studies (Goldstone

& Day, 2012). Such research should investigate factors that encouraged transfer between academic and clinical contexts. This could add to the theoretical and educational literature on transfer across contexts and could direct curriculum designers toward models that optimize transfer in health sciences education.

Acknowledgment

We sincerely thank the graduates of the MSc Ultrasound program who kindly gave their time to be interviewed regarding the impact of the PBL program on their learning and clinical practice.

References

- Al-Memar, M., Kirk, E., & Bourne, T. (2015). The role of ultrasonography in the diagnosis and management of early pregnancy complications. *Obstetrician & Gynaecologist*, 17(3), 173–181. <https://doi.org/10.1111/tog.12201>
- Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education*, 20(6), 481–486. <https://doi.org/10.1111/j.1365-2923.1986.tb01386.x>
- Biesta, G. J. J., & Burbules, N. C. (2003). *Pragmatism and educational research*. Lanham, MD: Rowman & Littlefield Publishers.
- Bryman, A. (2008). *Social research methods* (3rd ed.). New York: Oxford University Press.
- CASE. (2010). *Validation and accreditation handbook*. York, UK: The Consortium for Accreditation of Sonographic Education.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London: Routledge Falmer.
- Connolly, D. (2005). Continuing professional development of occupational therapists: A case study of problem-based learning in work. In T. Barrett, I. Mac Labhrainn, & H. Fallon (Eds.), *Handbook of enquiry and problem-based learning: Irish case studies and international perspectives* (pp. 145–155). Galway: CELT, NUI Galway.
- Diemers, A. D., van de Wiel, M. W. J., Scherpbier, A. J. J. A., Baarveld, F., & Dolmans, D. H. J. M. (2015). Diagnostic reasoning and underlying knowledge of students with preclinical patient contacts in PBL. *Medical Education*, 49(12), 1229–1238. <https://doi.org/10.1111/medu.12886>
- Doherty, A. (2008). *Report on a clinical review of mammography services at Midland Regional Hospital, Portlaoise for the Health Service Executive Dublin Mid-Leinster*. Dublin: Health Service Executive.
- Edwards, H. (2006). Critical thinking and the role of the clinical ultrasound tutor. *Radiography*, 12(3), 209–214. <https://doi.org/10.1016/j.radi.2005.06.004>

- Eliason, M. (2014). Assistant and auxiliary nurses in crisis times. *International Journal of Manpower*, 35(8), 1159–1184. <https://doi.org/10.1108/IJM-12-2012-0175>
- Facione, P. A. (2011). *Critical thinking: What it is and why it counts*. Millbrae, CA: Measured Reasons and the California Academic Press. Retrieved May 2, 2011, from http://www.insightassessment.com/pdf_files/What&Why2010.pdf
- Foley, J. M., & Kaiser, L. M. R. (2013). Learning transfer and its intentionality in adult and continuing education. In L. M. R. Kaiser, K. Kaminski, & J. M. Foley (Eds), *Learning transfer in adult education* (pp. 49–59). San Francisco: Jossey-Bass.
- Goldstone, R. L., & Day, S. B. (2012). Introduction to “New Conceptualisations of Transfer of Learning.” *Educational Psychologist*, 47(3), 149–152. <https://doi.org/10.1080/00461520.2012.695710>
- Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Thousand Oaks: Sage.
- HSE. (2011). *National miscarriage misdiagnosis review*. Dublin: Health Service Executive.
- Herbst, M. K., Rosenberg, G., Davids, B., Gross, C. P., Singh, D. Molinaro, A. M., Moore, C. L., (2014). Effect of provider experience on clinician-performed ultrasonography for hydronephrosis in patients with suspected renal colic. *Annals of Emergency Medicine*, 64(3), 269–276. <https://doi.org/10.1016/j.annemergmed.2014.01.012>
- Herr, K., & Anderson, G. L. (2005). *The action research dissertation*. London: Sage Publications.
- Hung, W. (2013). Problem-based learning: A learning environment for enhancing learning transfer. In L. M. R. Kaiser, K. Kaminski, & J. M. Foley (Eds), *Learning transfer in adult education* (pp. 27–38). San Francisco: Jossey-Bass.
- Kiguli-Malwadde, E., Gonzaga, M. A., Businge, F., Nakatudde, R., & Bule, S. (2010). Evaluation of ultrasound training in the problem based learning radiography curriculum at Makerere University, Uganda. *Radiography*, 16(4), 314–320. <https://doi.org/10.1016/j.radi.2010.05.003>
- Koshy, V. (2010). *Action research for improving educational practice* (2nd ed.). London: Sage Publications Ltd.
- Kulasegaram, K., Min, C., Howey, E., Neville, A., Woods, N., Dore, K., & Norman, G. (2015). The mediating effect of context variation in mixed practice for transfer of basic science. *Advances in Health Science Education*, 20(4), 953–968. <https://doi.org/10.1007/s10459-014-9574-9>
- Kvale, S. (1996). *InterViews: An introduction to qualitative research interviewing*. Thousand Oaks: Sage.
- McGinty, J., Radin, J. & Kaminski, K. (2013). Brain-friendly teaching supports learning transfer. In: L.M.R. Kaiser, K. Kaminski, & J.M. Foley (Eds), *Learning transfer in adult education* (pp. 49–59). San Francisco: Jossey-Bass.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis* (2nd ed.). London: Sage Publications.
- Mishler, E. G. (1986). *Research interviewing: context and narrative*. Cambridge, MA: Harvard University Press.
- Noffke, S.E., & Somekh, B. (2009). Introduction. In S. Noffke & B. Somekh (Eds.), *The Sage handbook of educational action research* (pp. 1–5). London: Sage Publications Ltd.
- Norman, G. (2009). Teaching basic science to optimise transfer. *Medical Teacher*, 31(9), 807–811. <https://doi.org/10.1080/01421590903049814>
- Patel, V. L., Yoskowitz, N. A., Arocha, J. F., & Shortliffe, E. H. (2009). Cognitive and learning sciences in biomedical and health instructional design: A review with lessons for biomedical informatics education. *Journal of Biomedical Informatics*, 42(1), 176–197. <https://doi.org/10.1016/j.jbi.2008.12.002>
- Pring, R. (2004). *Philosophy of educational research* (2nd ed.). London: Consortium.
- Punch, K. F., & Oancea, A. (2014). *Introduction to research methods in education* (2nd ed.) London: Sage.
- Roska, J. (2005). Double disadvantage or blessing in disguise? Understanding the relationship between college major and employment sector. *Sociology of Education*, 78(3), 207–232. <https://doi.org/10.1177/003804070507800302>
- Rubin, H. J., & Rubin, I. S. (2005). *Qualitative interviewing: The art of hearing data* (2nd ed.). London: Sage Publications.
- Savin-Baden, M. (2003). Disciplinary differences or modes of curriculum practice. *Biochemistry and Molecular Biology Education*, 31(5), 338–343. <https://doi.org/10.1002/bmb.2003.494031050263>
- Scheffler, I. (1999). Epistemology and education. In R. McCormick & C. Paechter (Eds), *Learning and knowledge* (pp. 1–5). London: Paul Chapman Publishing Ltd & Open University Press.
- Schmidt, H.G., Vermullen, L., & Van Der Molen, H. T. (2006). Longterm effects of problem-based-learning: A comparison of competencies acquired by graduates of a problem-based and a conventional medical school. *Medical Education*, 40(6), 562–567. <https://doi.org/10.1111/j.1365-2929.2006.02483.x>
- Shavell, V., Abdallah, M., Zakaria, M., Berman, J., Diamond, M., & Puscheck, E. (2012). Misdiagnosis of cervical ectopic pregnancy. *Archives of Gynaecology & Obstetrics*, 285(2), 423–426. <https://doi.org/10.1007/s00404-011-1980-0>
- Shen-Miller, D., & Smiler, A. P. (2015). Men in female-dominated vocations: A rationale for academic study and introduction to special issue. *Sex Roles*, 72(7), 269–276. <https://doi.org/10.1007/s11199-015-0471-3>
- Solomon, S. D., & Saldana, F. (2014). Point-of-care ultrasound in medical ultrasound. *New England Journal of Medicine*, 370(12), 1083–1085. <https://doi.org/10.1056/NEJMp1311944>

- Stanton, M. T. (2015). *A mixed methods investigation of the impact of problem-based learning on critical thinking in postgraduate sonography education* (Unpublished doctoral dissertation). Dublin: University College Dublin.
- Stanton, M. T., & McCaffrey, M. (2011). Designing authentic PBL problems in multidisciplinary groups. In T. Barrett & S. Moore (Eds), *New approaches to problem-based learning: Revitalising your practice in higher education* (pp. 36–49). New York: Routledge.
- Tan, J. Z.-Y., Waugh, J., Kumar, B., & Evans, J. (2013). Mucinous carcinomas of the breast: Imaging features and potential for misdiagnosis. *Journal of Medical Imaging & Radiation Oncology*, 57(1), 25–31. <https://doi.org/10.1111/1754-9485.12006>
- Trout, A. T., Sanchez, R., Ladino-Torres, M. F., Pai, D. R., & Strouse, P. J. (2012). A critical Evaluation of US for the diagnosis of pediatric acute appendicitis in a real-life setting: how can we improve the diagnostic value of sonography? *Paediatric Radiology*, 42(7), 813–823. <https://doi.org/10.1007/s00247-012-2358-6>
- Zeni, J. (2009). Ethics and the ‘personal’ in action research. In S. Noffke & B. Somekh (Eds), *The Sage handbook of educational research* (pp. 254–266). London: Sage Publications Ltd.

Dr. Marie Stanton is an assistant professor in the Diagnostic Imaging section of the UCD School of Medicine. Much of her teaching and learning work uses a problem-based learning approach. Her research interests include mixed methods research; health sciences education; the impact of PBL on critical thinking; the transfer of learning between academic and clinical contexts; and the importance of understanding the uncertainty of knowledge.

Prof. Suzanne Guerin is an associate professor in the UCD School of Psychology. A significant proportion of her teaching is in the areas of applied psychology and research design and analysis. She has supervised many PhD students to completion in a variety of fields. Her research interests include: teaching and learning, disability and health, and applied research.

Dr. Terry Barrett is an assistant professor in education development at UCD Teaching & Learning. She has extensive experience in designing and implementing PBL initiatives in a range of disciplines in Ireland and internationally. She coedited (with Sarah Moore) *New Approaches to Problem-based Learning: Revitalising Your Practice in Higher Education* (2010; New York: Routledge). Her research interests include problem-based learning and creativity, and mindfulness, and compassion in higher education. She has recently written *A New Model of Problem-Based Learning: Inspiring Concepts, Practice Strategies and Case Studies from Higher Education* (Maynooth: All Ireland Society for Higher Education).