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What teacher education students learn about collaboration from problem-based learning

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ABSTRACT

Group work, an essential component of learning and teaching in problem-based learning (PBL), is compromised if students' experiences of PBL are colored by dissatisfaction with the process or outcomes. For the potential benefits of PBL to be realized PBL group work must be genuinely collaborative to address students' personal and professional learning needs. Australian teacher education students (n=122) provided written reflections on PBL that enabled representations of their group work experience to be mapped using an Attitude, Skills, and Knowledge (ASK) framework to gauge understanding of the collaborative learning process (as learners and as future teachers). Attitudes identified as necessary for collaborative learning were valuing others' perspectives, interdependence, and learning about self. The Skills dimension characterized interpersonal, problem solving and group skills. Features of the Knowledge dimension were: generation, application, and dissemination of knowledge. Pedagogical knowledge was also evident through learning connections made by students to their future teaching practice.

Keywords: Problem Based Learning; Teacher Education; Collaborative Learning

INTRODUCTION

The defining features of problem-based learning (PBL) are: that professional 'real-world' problems provide the stimulus for student-driven learning that occurs in small groups; that it is effectively facilitated, not directed, by tutors; and, that it focuses on building content knowledge in tandem with developing problem-solving, self-directed learning, and

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collaborative, teamwork, skills (Barrows, 1996). Collaborative learning principles underpin the way PBL works, and collaboration within the group work structure of a PBL tutorial is prerequisite for the benefits of PBL as an approach to learning to be realized.

In terms of learning theory, there is a strong support base for incorporating collaborative group work as part of a student's learning experience. (2005) Social constructivist principles drawn from Vygotsky's (1976) notion of learning as a process of negotiating meaning, facilitated through language and interaction with others (Loftus & Higgs, 2005) sit comfortably with the more traditional cognitivist frameworks that underpin much contemporary (psychological constructivist) learning theory (see Bruning, Schraw & Norby, 2011). As well, social constructivist principles reinforce the idea that collaborative learning provides the opportunity for students to acquire both conceptual and procedural knowledge by using course content to grapple with problems they are likely to encounter in their future professional practice (Michaelsen & Sweet, 2008).

This paper contributes an in-depth examination of collaborative learning in the PBL tutorial because even though group work is an essential component of learning and teaching in PBL, tutors and students continue to experience difficulties related to working with and in groups, highlighted in previous research where students' negative perceptions of PBL have been shown to be largely colored by dissatisfaction with group work (Holen, 2000; Peterson, 1997; Pfaff & Huddleston, 2003). In this paper, we argue that setting up a group to be collaborative requires attention be given to process-related as well as content-related PBL outcomes because learning collaboratively depends on a set of group work specific attitudes, skills, and knowledge that students either bring to or develop within the group. An Attitude, Skills, and Knowledge (ASK) framework, developed by the authors (see Pourshafie & Murray-Harvey, 2013) is used to synthesize the dimensions of collaborative learning identified by teacher education students in the context of their problem-based learning as well as to examine the extent to which working collaboratively enhanced the learning experience. The ASK framework is extrapolated from theoretical models of the learning process such as the Model of Strategic Learning (see Weinstein, Jung, & Acee, 2010) that presents knowledge, skills, will, and self-regulation as critical, interacting components of strategic, self-regulated learning. Knowledge, skills and attitudes are terms generally referred to in the literature (e.g. Baartman & de Bruijn, 2011) as the elements that define professional competence (see also Lizzio & Wilson, 2004) and much of the PBL literature uses these terms in discussion around the purposes and practice of PBL. In this paper Attitudes indicate the dispositions and/or predispositions of students towards group work; Skills are the capabilities that students need for effective collaboration; and Knowledge refers to the essential concepts and principles needed to engage collaboratively, and for teacher education students includes pedagogical knowledge.

More than 10 years ago Holen (2000) claimed that while attention had been given to a range of issues related to achieving PBL objectives, "less attention seems devoted to the dynamics of the interaction within PBL groups." (p. 485) Since then, group processes have captured the attention of researchers who have investigated either in combination or separately, the knowledge, attitude and skill dimensions of group learning in PBL (see Mamede, Schmidt & Norman, 2006; Svinicki, 2007, for comprehensive overviews). Yet, despite the voluminous amount of research conducted on PBL in medical education including product (e.g. content knowledge) as well as process (e.g. problem-solving) outcomes, Schmidt, Rotgans and Yew (2011) a decade later, express the view that "the tutorial group, vital to the inner workings of PBL, remains in many respects a black box" (p. 802). Discussions around collaborative learning regularly appear in the business education and organizational learning literature indicating points of concern not dissimilar to those raised in the health sciences and education, where interest in collaborative learning is connected to preparing professionals who can work effectively with others (Hansen, 2006).

Collaboration – a graduate attribute

Early on in the adoption of PBL, the idea of PBL to be structured around group study included the argument that through collaborative teamwork PBL developed skills necessary for professional practice (Barrows & Tamblyn, 1980). Teamwork and collaboration continue to be regarded as important graduate qualities/attributes (Murray-Harvey, Curtis, Cattley, & Slee, 2005; Riebe, Roepen, Santarelli & Marchioro, 2010; Treleavan & Voola, 2008). Of the 39 universities across Australia, 22 universities list effective teamwork and/or collaboration skills as desired graduate attributes (The National Graduate Attributes Project, 2008). The stress on teamwork is mirrored in the international generic skills literature as well, exemplified in the Forfás (2007) review of trends in the United Kingdom, Ireland and the USA indicating a "…rise in the importance of generic skills, including the ability of individuals to work more autonomously; be self-managing, work as part of flexible teams, adapt to change, solve complex problems, think creatively and engage with innovation as a continuous process." (p. 3)

Collaborative learning - more than group work

Peterson (2004) identifies teamwork as one of three critical factors for successful PBL stating: "An ill-structured, authentic, and relevant problem is just the catalyst to make individuals come together. However, it takes more than just a good problem to make a group of people function as a team" (p. 640). Summers and Volet (2010) also argue that while working in a group on a common task may be a prerequisite for collaborative learning to occur "group work does not necessarily entail students learning collaboratively" (p. 474). These points concatenate with claims made elsewhere in the literature (e.g. Hansen, 2006; Page & Donelan, 2003) that problems with group work in PBL tutorials are likely to arise from the misconception that collaborative teamwork is an assumed outcome of merely placing students into groups.

Summers and Volet (2010) proposed that students need to engage in learning through co-regulation and co-construction of knowledge with other members of the group in order to realize the learning benefits (i.e. deeper understanding and retention) ascribed to collaborative learning. They identified key descriptors of co-regulation as negotiability, interactivity and dialogic interactions and characterized co-construction as high level cognitive-metacognitive processing, such as transformation of information through, for example, elaborations, explanations, and critical reflection on the content of the task (p. 474). In other words, collaborative learning involves more than distributing and reporting information.

Teamwork - more than group work

Michaelsen and Sweet (2008, p. 4) identify four prerequisites for successful group work: Groups must be properly formed and managed; students must be accountable for the quality of their individual and group work; students must receive frequent and timely feedback; and, group assignments must promote both learning and team development. In addition, students need prompts to explicitly think about group processes. Students need to know about the purpose of group work. These authors contend that few students have knowledge either about how groups work or the empirical evidence for the superior outcomes that collaborative learning offers when tackling complex tasks.

Emphasis on group work is not without its critics. Eva (2002) cited that research has not provided evidence that teamwork results in better success on learning outcomes than individual study, or that interdisciplinary teams regard teamwork more positively than others. Contrary to this, Schmidt, Rotgans and Yew (2011) in their review of the PBL process provide extensive research evidence that small group discussion, compared with individual problem analysis, not only stimulates the use of elaboration strategies, but also adds to longer-term knowledge retention. In addition to knowledge gains (the focus of cognitive constructivist researchers), Schmidt et al. (2011) also refer to the social and affective benefits of using group work to build communities of learners.

Collaborative learning in teacher education PBL

Newman (2005) highlighted that "it is not always clear what exactly is being done in the name of PBL" (p. 12) and used Bereiter and Scardamalia's (2000) notions of PBL (upper-case) and pbl (lower-case) to distinguish between PBL that aligns with "the structures and procedures first systematized by Howard Barrows" and pbl that is representative of "an infinite range of educational approaches that give problems a central place in the learning activity" (p. 12). The students who engaged in PBL in the study reported in this paper experienced upper-case PBL, following the 7-step Maastricht model (see Wood, 2003) albeit in a hybrid form since the PBL case studies, while interdisciplinary in conception and implementation were confined to one course that extended over one semester, and was delivered concurrently with lectures.

While students across all professions need to know that capability to work in a team environment is a workplace expectation, teacher education students also need pedagogical knowledge - to know how to form groups, how to design and implement team building activities, and how to create classroom environments that support collaboration (e.g. respect, trust, empathy). In a meta-learning sense, teacher education students need to connect their own learning about working in a group with their future teaching roles. In the context of the PBL tutorial the tutor is well positioned to model concepts related to this set of knowledge, skills and attitudes in the way they form groups and create a collaborative classroom ethos, to scaffold the development of collaborative learning skills by providing practice opportunities and explicit feedback on group performance, and to expect desired knowledge, skills and attitudes to be demonstrated through the assessment tasks.

Attitude, Skill and Knowledge dimensions of collaborative learning

Barrows and Kelson (1993) identified the development of attitudes and skills necessary for effective teamwork as a key educational objective of PBL asserting:

> The PBL Process is designed to encourage development of the skills necessary to work and learn effectively as members of a collaborative team working toward a common goal without sacrificing the development of the individual as a competent, confident, independent contributor to society (p. 3).

Among the attitudes, skills, and knowledge that PBL is said to develop, Newman (2005) lists 23 capabilities, of which six are related to the learning about effective group work that occurs through the group work process itself: collaborating productively in groups or teams, active listening, interpersonal skills, group and chairperson skills, coping creatively with conflict, and practicing empathy/ appreciating another person's point of view.

In order to capture teacher education students' perspectives on their PBL collaborative group work experience, and to better understand the potential of collaboration to optimize learning opportunities for students, two research questions guided the study reported in this paper: (1) what attitudes, skills, and knowledge about group work do teacher education students regard as important for teaching and learning? And, (2) to what extent was collaborative learning a feature of students' group work experience?

METHOD

Context of the study

For 10 years PBL was offered as an optional stream in one compulsory course 'Development Learning and Inclusive Teaching (DLiT)' where both undergraduate and postgraduate Bachelor of Education students together studied two cases over a 1-semester period. In 2009 a

Master of Teaching degree was introduced and postgraduate students with no teacher education background enrolled in the equivalent course but attended separate tutorial groups. All students attended the same lecture series, worked on the same PBL case studies, and undertook the same assessment tasks.

The PBL case studies

The two written cases that students studied followed the 7-step problem solving procedure for PBL cases used at the University of Limburg, Maastricht (after Gijselaers, 1995) where the 'story' of a case is disclosed to students progressively over a series of tutorials (see Wood 2003 for a concise summary of the process); in this course each case was conducted over three consecutive 2-hour tutorial sessions. The cases were developed in consultation with practicing teachers and designed to ensure (1) that students would cover the course objectives and content; (2) that the cases represented teacher problems not student deficits; and (3) authenticity – that the problems represented relevant and meaningful classroom issues. The case studies in this course were embedded within a program that included, along with the 2-hour PBL tutorial, a series of lectures, set readings and class activities related to the educational and developmental psychology content objectives of the course.

Preparation for collaborative learning involved providing students with preparatory reading and lecture input on related research, and included discussion in class about that reading, their previous positive and negative experiences of group work, and, based on the professional educational literature, in-class modeling and practice in forming and facilitating groups to be effective teams (Oakley et al., 2004). This preparation occurred prior to the PBL case study. A further departure from the way PBL works in other fields of professional study is that students were required to pay attention to the process of PBL teaching and learning as part of the assessment requirements of the course, to critique their PBL experience and to reflect on the positive and negative elements of this approach to teaching and learning. PBL tutors were all teachers with considerable school classroom experience and expertise as facilitators.

The PBL tutorial worked with classes varying between 15-25 students, grouped into teams of around five students per group. At the end of the third tutorial a fourth week of non-contact was given to allow time for groups to prepare an overview of their group's solution to the case problem to present to their peers in the following (fifth week). The tutorial process is summarized in Table 1.

Table 1: Overview of the Structural, Process and Content Elements of the Problem-based Learning Tutorials

PBL structure	**7-step Process**	**Content**
Tutorial 1 1-hour whole class student-directed tutorial followed by 1-hour meeting time scheduled for small group work.	Whole class works together on the problem (Steps 1-4: Clarify, Define, Analyze, Review); Small groups begin to formulate how they intend to work through the learning issues (Step 5: Establish learning goals)	The case unfolds step-wise through presentation of 'pages' of information following a 'trigger' scenario. A page of suggested references and resources is provided as a basis for inquiry.
Self-directed study	Students choose the ways they want to tackle the tasks they have set (Step 6: Self-study)	Students are encouraged to explore other potential sources of information.
Tutorial 2 (one week later) 1-hour reconvene and review 1-hour whole class tutorial and small group work	Small groups reconvene to discuss learning; Significant learning of groups shared with whole class (Step 7: Report and synthesize) Whole class proceeds with the case. Small groups re-form to continue work.	Further 'pages' of information are presented.
Self-directed study	Students choose the ways they want to tackle the tasks they have set	Students are encouraged to explore other potential sources of information.
Tutorial 3	Small groups reconvene to discuss learning. Significant learning of groups is shared with whole class Whole class proceeds with the case.	At the end of the tutorial students receive instruction on the focus of the group presentation task.
Non class contact	Preparation for presentations.	
Group presentations	15-minute Presentation of problem solution(s) + time for peers (anonymously) and tutor to write feedback.	Peer and tutor evaluations are recorded on prepared feedback forms and provided to the presenting group
Post presentation debrief	Each group records its own evaluation on one feedback form ready to discuss with tutor in light of peer and self evaluations Students complete self-assessment of tutorial performance and discuss responses first with group members and later in meeting with tutor	Small groups meet together Groups meet with tutor *Tutorial performance survey* (using a 4-point rating scale) assesses competence across four dimensions: Knowledge, Problem solving; Presentation skills; Personal/interpersonal communication skills

Course assessment

Three assessment tasks contributed to the overall grade for the course: (1) a 1000 word report that asked students: '*From your understanding of the PBL literature and your own experience, justify why you would or would not use PBL as a classroom teacher'* submitted mid-term after the first case and assessed by tutors (20%); (2) an oral presentation of each group's 'solution' to the case problem delivered to peers and tutors at the end of the semester and assessed by peers and tutors (30%); and (3) a 2000 word end of semester Learning

Evaluation submitted after the group presentation that instructed students to '*Critically reflect on your learning … to answer the question: How does your understanding of development, learning and inclusive teaching establish the foundations for you to become an effective teacher?'* (50%) This final paper required students to draw on reflections on learning and teaching made over the semester in their Professional Journal and to submit these with their Learning Evaluation paper. The journal entries for final two weeks specifically asked for reflections on group work skill development (penultimate journal entry) and their PBL experience (final journal entry).

Participants

Students who consented to researchers using their assignments for analysis provided background information on sex, age, and previous learning using PBL. Of the 122 students for whom data were available the proportion of males and females (36% males) was representative of the student cohort. The spread of participants was as follows: 74 were undergraduate, representing 40% of students enrolled in an undergraduate PBL class, and 48 were postgraduate, representing 70% of the postgraduate student group. Students' ages ranged from 19 to 52 years (Mean age 24.5 years; SD 6.81) with an average difference of 10 years between undergraduate and postgraduate students. Six students reported having been involved with PBL before.

Sources of data

The PBL report (Assignment 1), the Learning Evaluation (Assignment 2), and the final journal entry that sought *'reflections on experiences about learning and teaching using PBL'* were the written sources of data drawn on for qualitative analysis. The high demand made on students to reflect on their PBL learning experience progressively over the semester gave researchers confidence that final papers would elicit reasonably well-considered comments on PBL taking into account initial reactions to learning through PBL earlier in the semester, reading and writing about PBL, and having been engaged in learning through PBL for a full semester. Journal entries of 67 students (55% of participants), Assignment 1 reports submitted to researchers by 58 students (approximately 48% of participants) and Learning Evaluations of 46 students (approximately 38% of participants) that referred to PBL enabled these documents to be used for analysis.

Analysis

All three sources of data were entered into NVivo software (2008) and first coded using line-by-line or open coding (Strauss & Corbin, 2008) looking for words and phrases indicative of students' engagement either in group work or collaborative learning. Postgraduate students' data were coded separately from undergraduate students' data anticipating that there would be differences in the levels of collaborative learning engagement between the two groups. The first coding analysis focused on features of students' group work experiences. Further analysis looked for evidence or indications of students' engagement in collaborative learning.

The researchers worked together to determine the categorization within each of the ASK dimensions.

To assist with deeper analysis of the students' collaborative learning experiences, data were coded again looking for any evidence of co-regulation and co-construction. Evidence of shared interactions, negotiation and learning more by working with others were coded under co-regulation. In the same manner, any indication of students engaging in high level cognitive, meta-cognitive activity, deeper or higher level thinking, critical thinking, meta-learning and reflection were coded under co-construction. Coded data were then categorized in a matrix separating the co-regulation and co-construction responses between the postgraduate and undergraduate students.

In summary, students' texts provided a rich source of data on the extent to which collaborative learning was a feature of students' group work experience, and the meaning they attached to effective group/collaborative work for their learning and future teaching.

Results

References made to key elements of collaborative learning extracted from the PBL literature were amenable to classification as Attitude, Skill, or Knowledge. The ASK framework dimensions were then used to classify students' statements about group work/collaborative learning. Following this first classification further analysis revealed sub-categories within each of the dimensions. Table 2 provides a summary of indicative statements representing the three dimensions of Attitudes, Skills, and Knowledge, and the sub-categories. Notwithstanding the distinctiveness of the three dimensions there was some (inevitable) overlap, discussed later in the paper.

Table 2: Summary of Indicative Statements Made by Students on Attitudes, Skills and Knowledge for Effective Collaboration

Dimensions	Categories	Indicative statement(s)
Attitude (towards group work)		
	Valuing others' perspectives	• Openness to other people's point of view • Allowing contrasting opinions and perspectives • Can learn from others • Show humility in order to achieve the common goal
	Interdependence	• A sense of belonging/a place of learning for all • Taking ownership and feeling included • Enjoyable and conducive to developing new relationships/friendships • Trusting other group members • When people work together stronger outcomes can be achieved
	Learning about self	• Learning to recognize and show positive personal attributes • Noticing significant changes in behavior and perception e.g. confidence; self-esteem • Learning from each other and contributing to the whole group • Valuing achievements of the group over personal achievements
Skills (for group work)		
	Interpersonal (social)	• Capability to work within a team based environment • Sharing and communicating positively • Know how to act in social situations and get along with different people
	Problem solving	• Work as a group towards finding solutions to problems • Think critically to solve problems • Use higher order thinking strategies • Ability to hypothesize
	Group	• Sharing out roles and responsibilities • Group dynamics i.e. how groups work • Conflict resolution e.g. dealing with dominating members
Knowledge about (the purpose and principles of) group work		
	Generation	• Teacher not the main source of information but one who facilitates knowledge generation • Activates students' prior knowledge • Refines and sorts knowledge • Experience deeper level of learning • Investigate different ideas and concepts • Encourages participation and motivation to succeed
	Application	• Take responsibility of own and classmates' learning • Connect theory with real life • Build self-efficacy • Relevance to future work e.g. collaboration between other teachers, faculty members and parents to meet students' needs
	Dissemination	• Group members share previous knowledge and researched ideas

	• Group work as a forum to rationalize and clarify ideas • Encourages dialogue, questioning, initiative, creativity and reflection
Pedagogical	*Declarative knowledge* • Focus on the process over the outcome • Emphasis on students learning to become self-reliant and eventually independent • Teachers must understand the various dynamics that occur within classrooms • Builds skills and relationships vital to students' social, emotional and cognitive development outside the classroom *Procedural knowledge* • Effective practices need to be taught and nurtured e.g. explicit teaching of how to work well in a group • Select groups to accommodate diversity (race, gender, interests, abilities, disabilities, learning needs) to create an inclusive classroom • Assign roles to group members • Arrange classroom e.g. tables in groups - to facilitate group discussion • Teacher provides resources, guidance and support required for students to succeed

Although some differences were noted between undergraduate and postgraduate students' reflections they were not distinctive enough to warrant separating the presentation of results by group. Student quotes are provided with the text identifier to indicate the whether the text source was from a journal reflection (JR), the first written assignment (A1) or the final, learning evaluation (A2) and an identifier to indicate whether the student was an undergraduate (UG) or postgraduate (PG). Most excerpts quoted are from texts of different students. The results are reported in two sections, to address each research question.

What attitudes, skills, and knowledge about group work do teacher education students regard as important for teaching and learning?

Attitude

From students' statements about their group work experience three distinct sub-categories of Attitude were identified that have been labeled as 'Valuing others' perspectives', 'Interdependence' and 'Learning about self'.

Valuing others perspectives

Students considered group work more effective than working individually as not only 'students can feel valued' (A1, UG female) but also can 'see other people's perspectives' (A1, UG female). A student commented 'The group experience has been great and really opened my eyes to other people's point (sic) of view' (A1, UG female). Commenting on his observation of group work during teaching practice, one student stated that 'Small groups were successful only if all members had their voices heard' (A1, PG male) whilst another

affirmed that 'working collaboratively is very different than spending time socially' (A1, PG female).

Students' reflections manifested understanding of the value of a humble posture of learning. A student commented:

> It was a key outcome from our group...to understand in more genuine and practical ways that whilst individual differences and skills are important to add breadth to expertise and group outcomes, true collaboration has the potential to add so much more value to not only the project outcomes, but also to the personal and professional learning of individuals within the working group' (A2, PG female).

Interdependence

Undergraduate and postgraduate students alike recognized that 'group work is a vital part of student development and critical in social conditioning' (A1, UG female). Collaborative group work created a space 'to know people' (A1, UG female) and 'to come to satisfying conclusions as a group...' (A1, UG female). Working together was acknowledged as necessary 'to work out the objectives of the task and successfully complete it' (A1, UG male), thereby having an impact 'on academic and interpersonal outcomes' (A2, UG female). Students identified collaborative group work as enjoyable and conducive to developing 'new friendships' and through a sense of obligation to the group, taking 'ownership of their roles' (A2, UG male) within the group. Students felt that group work created a sense of belonging making it 'a place of learning for all students' (A2, PG male). They reflected that collaborative work enhances learning through 'social interaction, the power of purpose and is highly effective when student centred' (JR, PG female). Postgraduate students in particular articulated a deep understanding of the need for interdependence and an awareness of the need 'to rely on other group members to undertake their own self-directed learning to fill in your knowledge gaps' (JR, PG female).

Learning about self

Students 'found it surprising to realize that when all students interacted and bounced ideas off each other it was a very efficient way of completing the task at hand' (A1, UG male). They also noted personal attributes that contributed positively to their group reaching a common goal, for example, group work 'has taught me to value the achievements of the group over personal achievement. (JR, PG male). Another student 'noticed significant changes in [her] behaviours and perceptions to group work, that were both enlightening and empowering' and felt that 'even the more mature CAN change their views and behaviours and improve practice' (A2, PG female). Students developed awareness of themselves as learners and from each other. One student reflected that she was able to maintain 'cohesiveness through encouragement and positive affirmation', and for her future students 'I learnt that the student needs to be acknowledged as a whole person…' (A2, PG female).

Skills

The three discrete sub-categories that emerged from examination of students' statements about Skills were: 'Interpersonal (social) skills', 'Problem solving skills' and 'Group skills'.

Interpersonal (Social) skills

Students stated that through group work they were able 'to develop socialization and collaborative skills' and were enabled 'to work within a team-based environment', enhancing their skills through 'collaborative and cohesive structures of learning' (A1, UG female). One student commented that 'The active involvement within groups develops the social skills necessary for cooperation and teamwork' (A1, UG female). Students articulated the importance of using group work in their own classes as it helps to develop 'skills and relationships' essential to their 'social, emotional and cognitive development outside of the classroom' (A2, UG female). Students believed that 'collaborative group work' was an effective way to 'learn how to act in social situations and to learn to get along with different people' (A2, UG female).

Students were aware of the valuable 'communication skills and interpersonal intelligence' (A1, PG male) and 'professional and team working skills' learnt during collaborative group work which equip students 'for life beyond university' (A1, PG male).

Problem solving skills

Students considered that 'to collaborate and work as a group through the problem' (A2, UG female), enhanced their 'problem solving skills' (A2, UG female). They felt students at every level needed to be equipped with problem solving and collaborative skills (JR, PG female). Others reflected on their positive experience of working 'collaboratively towards finding solutions to problems' (JR, UG female) noting that in order 'to solve or help to solve the PBL case' they were engaged in deep critical thought about learning and teaching (JR, UG female).

Group skills

We identified three types of group skills that students regarded as necessary for working effectively with others in PBL and for fostering a positive learning environment as future teachers. Students referred to the need to be skilled in sharing roles and responsibilities, for example 'Through working in our own groups many different skills were developed further such as communication, delegation, researching, presentation just to name a few' (JR, PG male). They also recognized the importance of being able to skillfully manage group dynamics, as described by a student who reflected that 'I will need to understand myself the dynamics of group work and how they function so that I can facilitate and oversee success' (A2, UG female). The need for conflict resolution skills was suggested in statements like 'teachers must support their students on a variety of levels, including promoting effective group interaction' (JR, PG female), 'my group was not a well functioning group despite trying

myself. It has left me with many questions on how to handle 'difficult' people' (JR, PG female), and 'the students' 'relational and cooperative skills' grew and they displayed 'inclusive behaviour' and were able to deal with 'conflict' (A1, UG female).

Knowledge

The Knowledge dimension represents ways in which students considered that their subject matter learning was enhanced through collaborative endeavor. Three sub-categories of Knowledge statements were identified: Generation of knowledge, Application of knowledge, and Dissemination (diffusion and sharing) of knowledge. A further Pedagogical knowledge category was created to represent knowledge about how collaborative learning might be used as an instructional approach.

Generation of knowledge

The process of group work 'using piece by piece information, discussion, previous knowledge and experience, brain storming and further independent investigation' (A1, UG female) generated knowledge to be able to solve the problem. Students' active involvement in the generation of knowledge in the PBL tutorial brought with it a realization of 'the importance of collaboration work in the classroom' which meant that 'no longer is the teacher the main source of information but facilitates and asks many open ended questions' (A2, UG female). In generating knowledge, collaborative group work helped to activate students' prior knowledge and allow 'refining and sorting' (A2, PG female) of knowledge. Their search for pieces of information allowed group members to 'experience a deeper level of learning' (A1, PG female). The investigation of 'different ideas and concepts both autonomously and within a group' (A1, PG female) led to a number of students commenting on retention of greater amounts of knowledge.

Application of knowledge

Collaborative group work led to students' knowledge and ability to 'coordinate effective student learning' (A2, UG female) and to take 'responsibility for their work' (A2, UG female). Students felt that the discussion of the case using their collective information not only developed social skills, but also highlighted the need 'to take responsibility for their own learning, as well as their classmates' (A1, PG male). One student remarked that 'the shared discussions, stories and experiences extended my knowledge of people's teaching contexts and helped me to connect the dense theory of my course with real life' (JR, PG female) and another commented 'Group work helped me to make concrete many of the strategies I had brought to the group, improving my own self-efficacy' (JR, PG female).

Dissemination (sharing) of knowledge

Students' interaction with each other during collaborative group work created a space to share their knowledge. As one student observed 'group members started scaffolding the learning process by bringing to the table what they already knew as well as ideas they had researched'

(A1, PG female) thus providing a 'forum to rationalize ideas'. Students were then able to further disseminate their generated knowledge by finding and presenting a solution to the whole group (A2, PG female). Through the process students communicated their ideas and supported each other's learning which in turn 'developed ownership' and 'increased motivation' (JR, PG male). A common refrain of students was that the opportunity to generate and disseminate knowledge in their group 'increased motivation to do a good job' (JR, PG male).

Pedagogical knowledge

In relation to students' pedagogical knowledge there were multiple reflections that indicated students had gained a deeper understanding of the principles and practices of group work in order to facilitate collaborative learning. These indicators of Pedagogical knowledge are identified in Table 2 as Declarative and Procedural knowledge to distinguish between students' statements that focused on *understanding* from those that focused on *implementation*. The following quotes are representative of many made in relation to students' teaching practice:

> (a) …there can be big problems with group dynamics. Especially as I experienced at teaching prac that the special needs kids are not wanted by other students in groups as they feel that these students slow them down. (A1, UG female)
>
> (b) Another positive which I would make use of in the classroom is the skills developed during the PBL process. Skills such as research skills, group work and presentation experience are all very valuable in both school and life situations. (A1, UG female)
>
> (c) A simple teaching strategy for inclusion is to incorporate group work into the classroom. Sounds easy enough? Not quite. As stated previously it is extremely important for teachers to have a solid understanding of the various dynamics that occur within classrooms so when selecting groups for group work there has to be some subtle selections on the teacher's behalf. (A2, UG male)

To what extent was collaborative learning a feature of students' group work experience?

To gauge the extent to which students' PBL group work was collaborative, the Summers and Volet (2010) key co-construction and co-regulation descriptors were used to analyse students' written reflections. For Assignment 1, 18 of the 28 postgraduate and 14 of the 30 undergraduate texts analyzed conveyed that students' group work experience involved collaboration. For assignment 2, collaborative learning was evident in nine of 17 postgraduate, and 15 of 29 undergraduate, students' texts. Of the 67 students who referred to collaborative learning in their final journal reflection on PBL eight were postgraduates and nine were undergraduates.

It was not always possible to tidily separate descriptors because some statements included both co-regulation and co-construction descriptors in the quoted excerpt. To represent the range of views expressed as fully as possible, each quote is from a different student.

Co-regulation was typically revealed through statements showing shared interactions and negotiation:

> In conducting this case study, my group excelled at it because we all used our strengths and researched topics that had meaning to us as individuals however when put together, we were a great team. This approach will be used in my class because I have had first hand experience of the power of having students take ownership and feel included. (A2, UG male)

And co-construction was exemplified in statements that recognized collaborative learning as a qualitatively different experience:

> (a) The group work I engaged in seemed different from other group work… I found that each member was more willing to take part in the problem solving, as we did not have all the information and had to learn from one another's experiences and points of view to get to the solution of the problem at hand. (A1, UG female)
> (b) At first I was a little confused about the process and its requirements. However, after the first few weeks I found myself engaging in a deep critical thought on issues very relevant to teaching and developing and contributing ideas to group and class discussions in an effort to solve or help solve the PBL case. (JR, UG female)

There were mainly positive but also some negative reflections in relation to the negotiation element of co-regulation with the more negative statements nevertheless conveying recognition of the potential of, and need for negotiation, to foster a collaborative environment:

> (a) I was initially skeptical about PBL but was won over by the process. It's an effective way of integrating knowledge but only one way. It's a good way of integrating learning with negotiated group activity. (JR, PG male)
> (b) Both the PBL cases seemed to be constrained by explicit and sometimes repetitive questions, whereas I felt our class would have greatly benefitted from more student-driven and negotiated questions. I actually highly enjoyed the basic process of PBL – it's just the execution of these that fell flat. (JR, PG female)

And in relation to learning more by working with others:

> There appeared to be a lack of clarity on how we were to go about problem solving. I guess the irony of it all is that through the PBL process our group learnt how to problem solve.

> The problem was not just the case study but it was in what processes and techniques can we use to solve problems. (JR, PG female).

DISCUSSION

The ASK framework has been successfully employed in previous research (Pourshafie & Murray-Harvey, 2013) and was used similarly in this study to capture the Attitude, Skills, and Knowledge dimensions of teacher education students' collaborative learning PBL experience. As learners and in relation to their future roles as classroom practitioners this research identified that collaborative learning supports a space conducive to exchange of ideas in a morally, socially and intellectually uplifting environment.

Drawing on the well-considered reflections of students that provided the data for this study, it was evident that for most, group work held meaning for them above and beyond the sense of task completion. Approximately half of the texts analysed, representing equal numbers of postgraduate and undergraduate contributions, indicated students had engaged collaboratively, in accord with the co-regulation and co-construction features of group work proposed by Summers and Volet (2010). One point of departure in our findings from research reported elsewhere of higher level cognitive processing through group work (see Schmidt et al., 2011) is that our students provided minimal reference to group work delivering benefits (or losses) in relation to higher level cognitive / metacognitive processing, using those terms. As suggested by Michaelsen and Sweet (2008) this may require that students receive explicit prompts to trigger their thinking about group processes; a reminder for teacher education PBL tutors to draw students' attention to the professional language of educators.

Adopting PBL in a teacher education context involves the need to focus attention on making explicit connections for students with both the teaching and the learning processes that underpin PBL; connections that students are required to reflect upon in light of their own future teaching practice. In terms of working with PBL in teacher education, notwithstanding that teacher educators are experienced and effective facilitators with expertise in the field of teaching and learning, the meta-teaching and meta-learning (Biggs, 1985) focus adds another layer of complexity to the PBL tutorial. It has been this meta-focus on PBL however that offered a unique opportunity to draw on the students' PBL experience.

The hesitancy, or low level of self-efficacy (see Bruner, 1997) for implementing effective group work, communicated by both undergraduate and postgraduate students serves to highlight that working with PBL is a demanding undertaking, for teachers as well as for learners. The students' expression of their pedagogical concerns nevertheless draws attention to two important points emerging from this study. The first is that teacher education students, through PBL, can come to appreciate the attitudes, skills and knowledge required for collaborative learning. The second point, based on comments that gave equal attention to

attitude, skill and knowledge dimensions of collaborative learning, is that the collaborative learning afforded by PBL offered students a holistic learning experience, and for this group of prospective teachers, a holistic frame of reference for professional practice.

There were no striking differences between undergraduate and postgraduate students' understandings about collaborative learning in that contributions from both groups were similarly amenable to classification in terms of the ASK dimensions and their sub-categories. With regard to pedagogical knowledge, undergraduate and postgraduate students alike could articulate links between the group work they experienced and possibilities for their own teaching. There were however, differences between the groups with postgraduate students indicating a deeper level of reflection about collaborative learning issues. This is not surprising since these more mature students, on average 10 years older than the undergraduates would have more life experiences to draw upon to make connections between learning and teaching. Notwithstanding this qualitative difference between the groups, it is not possible to say whether postgraduates worked more or less effectively within their groups than undergraduates. It could be considered a limitation of this study that only students' written work was available for analysis. Additional observational data of students' interactions would certainly strengthen findings by providing independent assessment of collaborative learning within the group. It is worthy of note that a minority of students whose texts were scrutinized expressed negative views about group work. Nevertheless, in describing what was unproductive or unsatisfying, in the main with reference to lack of skills for dealing with problematic group dynamics, they conveyed insightful reflections about collaborative learning regarding what could or should have been possible.

CONCLUSION

The PBL tutorial group, because it is purposefully embedded within the broader PBL process, creates opportunities to meaningfully develop knowledge, attitudes and skills pertinent to collaborative learning. Developing collaborative learning capabilities requires attention be given to building students' knowledge about effective teamwork, assisting students to make explicit connections between attitudes towards working collaboratively and achieving learning outcomes, and identifying with students, the specific collaborative learning skills required, and acquired through the process of group work. And according to these teacher education students, PBL helped to make explicit a range of learning and teaching processes that will inform their future teaching practice.

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