

# **Collaboration In Implementing Problem Based Learning For Nursing Education: Nurse Educators' And Managers' Views In South Africa.**

**M A RAKHUDU<sup>1</sup> AND M DAVHANA- MASELESELE<sup>2</sup> USHONATEFE USEH<sup>3</sup>**

1. Department of Nursing Science. North-West University South Africa

2. Office of the Rector: North West University South Africa [mashudu.maselesele@nwu.ac.za](mailto:mashudu.maselesele@nwu.ac.za)

3. School of research and post graduate studies. North-West University. South Africa

[Ushonatefe.useh@nwu.ac.za](mailto:Ushonatefe.useh@nwu.ac.za)

## **Abstract**

**Background:** Problem based learning is advocated as teaching strategy for development of the 21<sup>st</sup> century health care practitioners. Collaborative partnerships are much-touted values in organizational life today

**Purpose:** To explore and describe the perceptions of nurse educators and manager on collaboration in implementing PBL in nursing education in South African context

**Methodology:** An exploratory sequential mixed method was used to collect data from purposively recruited participants from three of the five South African universities implementing PBL in nursing education and three North-West Provincial hospitals where PBL students are place for clinical learning. Ethical clearance certificate is **NWU-00033-11-A9**

**Results:** Both qualitative and quantitative data indicated the need for various types of collaboration; benefits of collaboration to staff, students, organizations and health care users; factors to successful collaboration in implementing PBL

**Conclusions:** Successful implementation of PBL can be achieved through collaboration with clinical spaces. The strategic management and leadership should be committed to the collaboration by offering support and commitment of time, energy and resources.

**Recommendations** For practice, the strategic management and leadership should be committed to the collaboration by offering support, commitment of time, energy and resources. Effective communication should be to promote participation in the collaboration. Further research on collaboration in implementing PBL at different levels of operations; cultural influences on collaboration; criteria to assess effectiveness of collaboration is necessary.

**Key Concepts:** Collaboration, implementation, perceptions, and problem-based learning, nursing education.

## **Introduction**

Nursing education in South Africa is increasingly under pressure to focus on developing clinicians prepared to work in rapidly changing, multicultural environments influenced by technological advances and fiscal constraints;. In addition, the challenges brought about by the patterns of diseases such as HIV, tuberculosis, Sexually Transmitted Diseases (STDs), non-communicable diseases and malnutrition also contribute to challenges related to quality of care services rendered. To meet these challenges, nurse educators are required to redirect their teaching strategies to those that promote critical thinking in order to develop nurses who are critical, reflective and analytical. It is, therefore, important to continually adapt the teaching strategies to meet the changing health care needs of the country

In today's ever changing and demanding healthcare environment, developing nurse practitioners require move from traditional teacher centred to learner centred or participatory pedagogies. Problem based learning (PBL) is perhaps the most innovative participatory pedagogy conceived in the history of education (Koh, Khoo, & Wong, 2008; Hung, Jonassen & Lui 2008) Effectiveness of PBL in facilitating self-directed and collaborative learning, problem solving and decision making skills has been widely documented (Barrow, 2003; Rideout, 2001; Albanese, 2000; Gwee, 2009)

PBL is an educational approach that organizes curriculum and instruction around carefully crafted "ill-structured" problems. Students gather and apply knowledge from multiple disciplines in their quest for solutions. Guided by teachers acting as cognitive coaches, they develop critical thinking, problem solving, and collaborative skills as they identify problems, formulate hypotheses, conduct data searches, perform experiments, formulate solutions and determine the best "fit of solutions to the conditions of the problem" (Haith-Cooper 2000). Problem-based Learning enables students to embrace complexity, find relevance and joy in their learning, and enhance their capacity for creative and responsible real-world problem-solving (Haith-Cooper, 2000; Delva, Woodhouse, Hains, Birtwhistle, Knapper & Kirby, 2000). According to Gwee (2009) PBL can offer a more holistic, value-added, and quality education to energize student learning in the healthcare professions in the 21st century.

Having adopted PBL, the Department of Nursing Sciences (DNS) of North-West University (NWU) require a paradigm shift in undergraduate education and emphasise that a collaborative effort is required for effective implementation of PBL. Thus, the need to explore the perceptions of nurse educators and managers was mandatory for effective implementation of PBL in nursing education.

According to Cape Higher Education Consortium (2004), Collaboration is basic to academic enterprise. Collaboration with key stakeholders, especially where students are placed for clinical learning, will enhance the mentoring and empowerment of the students and nurse educators as well as nurse managers and other preceptors in PBL. For this reason, the exploration of the nurse educators' and nurse managers' is necessary. In a collaborative effort, partners share knowledge, expertise and resources. Thus, nurse educators need not remain in isolation while learning to use PBL. Collaborative efforts and sharing of resources and success are mandatory in educating nurses for the 21st century (Medley & Horne, 2005).

Internationally, differences of opinion exist between nurses 'in service' and nurses 'in education' with respect to new competencies for graduate and diploma registered nurse preparation. Greenwood (2000) states that the service sector nurses complain that new graduates (of either diploma or degree programme)

are inadequately prepared for clinical practice in that they are “deficient” in certain skills. Nurse educators state that expectations of nurse clinicians are unrealistic given the aims of contemporary education of preparing “practitioners who are reflective and committed to lifelong learning” (Greenwood, 2000). Given this scenario and the tension between academic and clinical nurses, it becomes imperative to investigate and develop a collaborative model for effective implementation of PBL within the nursing education context.. Whether it is coming together to write a paper, evaluations of students or more complex relationships constructed around shared research facilities or teaching programs, most academics will immediately recognize collaboration as endemic to the academy (Cape Higher Education Consortium 2004)

Several publications describe a variety of collaborative models: inter-professional (Furber, Hickie, Lee, Mcloughin, Boggis, Sultin, Cooke, Wakefield, 2004; Reynold, 2004), and collaborative learning, yet, few explored inter-institutional and intra-institutional collaboration in implementing PBL in nursing, especially in the South African context. The collaboration in implementing PBL resulted from the health care system that requires provision of collaborative and seamless services (Furber et al., 2004). This has resulted in a need to explore the perceptions of the key role player in nursing education on collaboration for implementing PBL in nursing education.

Other models of collaboration in nursing education exist amongst colleges and universities in implementing collaborative partnerships in Ontario, Canada with the aim to design, disseminate and evaluate a faculty development programme in nursing (Matthew-Maich et al., 2007) and an amalgamation of colleges for implementation of PBL (Drummond-Young, Brown, Lunyk Child ,Maich, Mines & Linton 2010). The dearth of literature on collaboration in implementing PBL nursing education and clinical services in South African context has been found. For this reason, the need to explore the perceptions of nurse educators and managers in implementing PBL in a South African context is very critical. According to Souers, Kauffman, McManus and Parker (2007), collaborative partnerships between and among academia, nursing practice and other key stakeholders can help bridge the gap by providing opportunities to share perceptions, creating an environment of shared knowledge and learning as well as networking opportunities, leading to further enabling preparation for potential future staff.

## **Problem Statement**

The unresolved challenges arising from the introduction and implementation of Problem Based Learning (PBL) teaching method in the North-West University (NWU) require collaborative efforts to effectively implement this teaching method.

When the Department of Nursing Sciences (DNS) introduced Problem Based Learning (PBL) in 2002 for the third and fourth year students, it created some needs across several levels in the department.

1. At the departmental level, there was lack of coordination for class teaching, clinical learning, mentoring, sharing of information, and lack of capacity as some educators were not trained in PBL.
2. At student level, an exploratory study was first conducted in 2008 (Rakhudu, 2008) on the three groups of students determining their opinions on the implementation of PBL. Despite their disadvantaged background, the responses of the students indicated that: they found the use of PBL

beneficial to them and wished that PBL should not be discarded but strengthened and they recommended further that all the users of PBL such as facilitators, nurse educators, nurse managers and preceptors be prepared to effectively understand the implementation of the teaching method.

In addition, the Department of Nursing Sciences External Program Evaluation (EPE) also found in 2008 similar challenges mentioned above and recommended that: 1) PBL needs to be introduced at all levels of training: students, 2) facilitators, nurse educators, nurse managers, 3) preceptors and all staff members involved in implementing PBL the nursing education; 4) collaboration with other centres offering PBL should be developed; and 5) improvement of clinical learning by accompanying follow-ups of students by nurse educators and change of attitudes of professional nurses towards the students.

For these reasons, exploration of opinions of these stakeholders in nursing education is deemed critical to deal with the challenges impeding the effective implementation of the PBL within the Department of Nursing of the North West University

### **Objectives of the Study**

The following are specific objectives of this study:

1. To explore and describe the opinions of the nurse educators nurse managers and preceptors regarding collaboration in implementing PBL in nursing education;
2. To measure and describe the opinions of nurse educators, nurse managers and preceptors regarding collaboration in implementing PBL;

### **Research Questions**

In a qualitative study, the researcher does not embark on research with a definite hypothesis as stated by (Creswell, 1994; and Mouton, 1996). The 'grand tour' questions that guided this study included the following:

1. *“What are the nurse educators, and nurse managers’ opinions on collaboration in implementation of PBL in nursing education?”*
2. *What are the opinions of key role-players regarding the benefits of collaboration in implementing PBL in nursing education?*
3. *What are factors contributing to a successful collaboration in implementing PBL in nursing education*

### **The Significance of the Study**

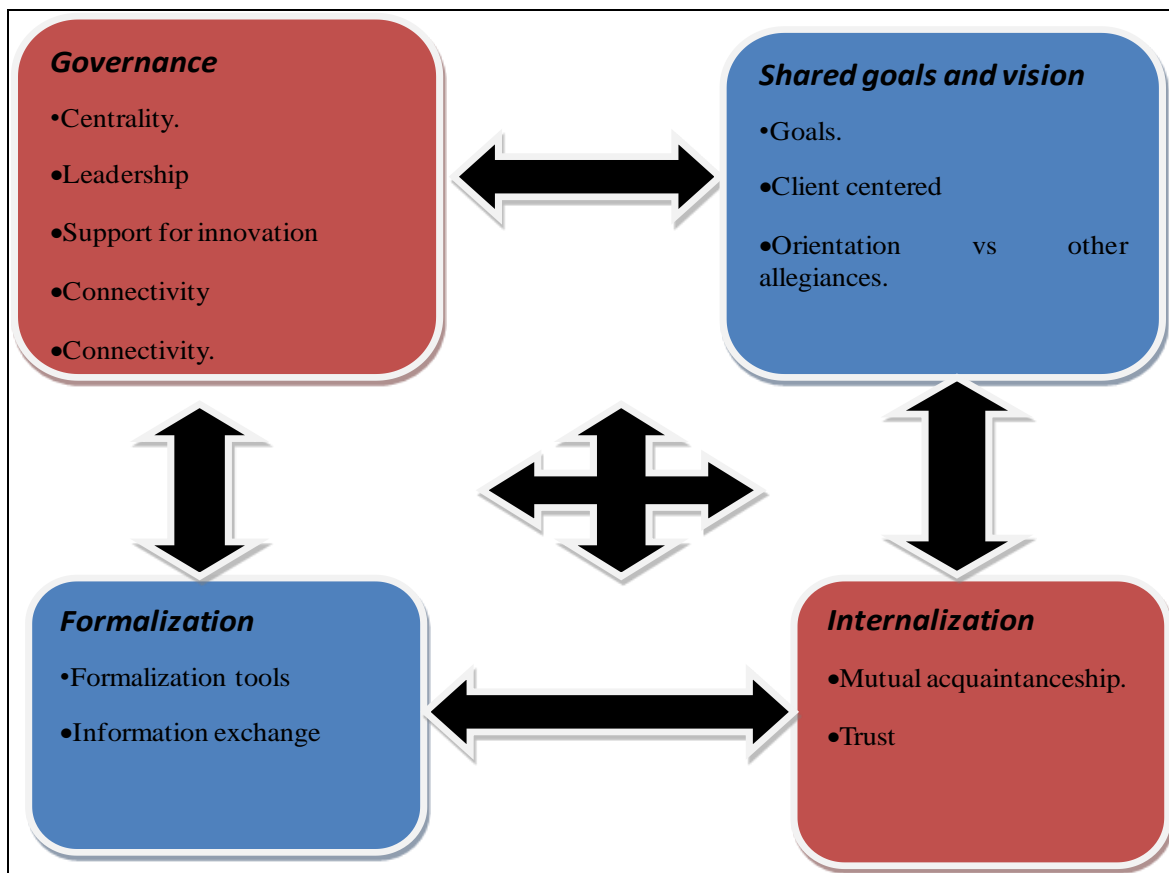
The outcome of the study may inform the nursing profession in policy development for best practices in PBL and curriculum development, which will produce market-related practitioners as well as further research

### **Conceptual Framework**

The theoretical assumption upon which this study is based is D'Amour, Goulet, Labadie, Martín-Rodriguez, and Pineault's (2008) four dimensional collaborative models in health. The model

suggests that collective action can be analysed in terms of four (4) operationalized dimensions.in care settings. Figure 1 depicts the conceptual framework used to guide the study.

**Figure 1: Dimensional collaboration model (adapted from D’Armour et al., 2008)**



As the figure shows, the four dimensions are interrelated and influence each other. The relational dimensions are:

1. **Shared goals and vision**, which refer to the existence of common goals and the appropriation by the partners, the recognition of divergent motives and multiple allegiances and expectations regarding collaboration (D’Armour et al., 2008).
2. **Internalization** refers to awareness by professionals of their interdependencies and of the importance of managing them, and which translates into a sense of belonging, knowledge of each other's values, discipline and mutual trust. (D’Armour et al., 2008).
3. **Formalization** is defined as the extent to which documented procedures that communicate desired outputs and behaviours exist and are being used. Formalization clarifies expectations and responsibilities. (D’Armour et al., 2008).
4. **Governance**, that is, the leadership functions that support collaboration. Governance gives direction to and supports professionals as they implement innovations related to intra-professional and inter-organizational collaborative practices. (D’Armour et al., 2008).

**Methodology**

A mixed method design (MMD) was utilized in this study. The goal of mixed methods research was to draw on the strengths and minimize the weaknesses of both types of research (Creswell & Clark, 2014).

An exploratory sequential approach of mixed method was used in which the researcher commenced by conducting individual semi-structured interviews and focus group discussions with nurse educators, and managers to obtain their opinions or perceptions on collaboration in implementing PBL. The themes identified through analysis of interviews were used to develop questionnaires that were sent participants (Schifferdecker & Reed, 2009). This approach was beneficial as it promoted triangulation in this study.

Table 1 depicts the components of the MMD used for this study

**Table 1. Components of the exploratory mixed method**

<b>Component.</b>	<b>Qualitative Method.</b>	<b>Quantitative method</b>
<b>Type</b>	Core	Supplementary
<b>Purpose</b>	Explore and explain the opinions	Used to supplement the qualitative component by quantifying the descriptions How many? How often? To what extent?
<b>Design</b>	Explorative contextual and descriptive approach	Descriptive survey
<b>Population and sample</b>	Nurse educators from institution offering PBL in RSA and nurse managers from clinical facilities where students are placed for PBL in North West Province of South Africa. Three out of five universities were purposively invited to participate	All the nurse educators in the five universities offering PBL education in pre-registration programme and the nurse managers in North-West Province clinical facilities where PBL students are placed for learning
<b>Data collection method</b>	Individual semi structured interviews and focus group discussion Use of audiotapes and field notes	Self-administered questionnaire based on the themes from the qualitative component and literature. Questionnaires were sent to participants.
<b>Data analysis</b>	Transcribing Coding	Use of SPSS 20 Descriptive , comparative and inferential statistics
<b>Quality measures</b>	The research questions were piloted as another way to ensure truth value: Impartiality was promoted by peer review. Presentations were done at doctoral seminars. Member checking : the findings was taken back to participants and ensuring that they agree	Data collection tool was piloted and open-ended questions on the questionnaire were reduced because most of those were not answered.

**Ethical Measures**

A written permission to conduct research was obtained from the relevant Universities’ Faculties of Health Sciences and North West Provincial Department of Health .**Ethical clearance** to conduct the research was obtained from North-West University. (**Ethics number: NWU-00033-11-A9**).The participants were informed and asked to sign a consent form, and a written consent was obtained from the Programme Coordinator.

Participants participated voluntarily. No coercion or pressure was exercised. Confidentiality was maintained during data collection and this important norm was announced at the beginning of each and every interview. Names of individuals were not used and numbers were assigned to the participants during data collection and analysis.

**Results**

Realization of the qualitative sample was achieved after interviewing eleven (n=11) participants and five FGD (n=33). The distributions by position were as follows: seven (n=7) nurse managers and four (n=4) nurse educators individually. From the quantitative component, 120 questionnaires were personally delivered and also sent through emails to the participants. . Overall, 96 were returned, representing 80% return rate.

**Characteristics of participants in both components**

The table 2 depicts the characteristics of the participants

**Table 2: Characteristics of Participants**

<b>Variable</b>	<b>Qualitative Component</b>	<b>Quantitative Component</b>	<b>Merged Results</b>
Age	Minimum = 31yrs Maximum = 64 years	Minimum = 25 Maximum = 62 years Mean = 49; SD = +- 14	Minimum = 25 Maximum = 64 years
Gender	Female: n= 38 Male :n= 6	Female n= 85 Male n= 11	Female n = 123 Male n= 17
Position	Nurse Educators = 22 Nurse Managers n= 22 Preceptors n= 0	Nurse Educators n =51 Nurse Manages n = 30 Preceptors n=17	Nurse educators n= 73 Nurse Managers n= 52 Preceptors n= 17
Experience in current position	Maximum experience is 30 years and the minimum years is 5 years	n=39;44.2 %) had more than 10 years’ experience in the current position, (31.6 %) had 6-9 years and 23.2% had 2-5 years’ experience in the current position.	The majority of participants had more 10 years’ experience in current position
Highest Qualification	PhD, = 8 Masters ,= 10 Post Basic Dipl, n=21 Degree in nursing, n =5	PhD, n= 4 Master’s Degree, n= 30 Post-Basic Diploma, n=45 Degree in Nursing, n= 17	PhD, n = 12 Master’s Degree, n=40 Post Basic Diploma, ,n = 66 Degree in Nursing, n=22



## **Themes from data**

Both qualitative and quantitative data indicated the need for various types (inter-professional, inter-disciplinary, and inter-institutional) of collaboration; benefits of collaboration to staff, students, organizations and health care users; and factors to successful collaboration in implementing PBL.

### **Theme 1: Participants verbalized the importance of different forms of collaboration**

All the participant expressed the need to collaborate in implementing problem based learning in nursing education. Collaborations are increasingly becoming the format for ways of doing work as the nature of learning and teaching is being dramatically transformed. According to Huxham and Vangen (2000), the last decade has seen a worldwide movement toward collaborative governance, collaborative public service provision, and collaborative approaches to addressing social problems.

The following are quotes from participants

*Oh ----- The collaboration is long overdue. Training of students requires collaboration. Even, in Tswana expression it is said “Ngwana ka sejo se a tlhakenelwa” which literally means Bringing up a child is like food and requires group efforts” (Meaning bring up a child requires collaborative efforts). (Educator)*

Nurse Manager said this

*Collaboration to me is necessary. And especially where people are handling almost the same type of things, type of line...like for instance if people are doing teaching, basically they can share whatever they have. ...and...again it basically would assist in improving certain things within the performance of whatever line people are in, like for instance in education, where people would share information, people who have the necessary knowledge would also advance that knowledge to those people who don't know, so to me, collaboration is really necessary to address areas which are like almost similar, and where resources are limited*

This is congruent with the assertion by Walter, Davies and Nutley (2003); Montiel-Overall (2005) and Bedwell et al., (2012) who perceived collaboration and partnerships as much-touted values in organizational life today. Collaborating with other key role players, nurses in academia and in service settings can directly impact nursing education and practice, often effecting changes and achieving outcomes that are more extensive and powerful than could be achieved by working alone. Kirschling and Erickson (2010) and D' Amour et al. (2008), in their models of collaboration, also reported that collaboration is the central in any collective undertaking.

The categories that emerged from this theme were of the opinion that intra-professional, inter-professional and inter-institutional collaborations are vital in implementing PBL in nursing education. These results were congruent with those from the quantitative component where 79% participants indicated the importance of Intra-professional collaboration, 75% for inter-professional, and 69% for inter-institutional collaboration

### **Sub-theme 1: Intra-professional collaboration**



In general, participants indicated the need for collaboration within the nursing profession especially between the nurse educators and professional nurses in the clinical space. The expressed many opinions similar to the following:

**This is what one educator said:**

*I am just going to tell you what I think. I think that the major stakeholders need to be firstly the clinical practitioners or spaces. I think of partnership with sometimes...I think we sometimes work in such isolation with our clinical partners. So I think I know that there is a move like clinical training grants that are now being initiated within our institutions that will bring in clinical preceptors that can be part of the classroom learning as well*

**This is how one nurse educator said it thus:**

*I also think as educators within the university we should collaborate. Midwifery, community nursing and mental health educators as well as general nursing facilitators we need to collaborate in designing scenarios and evaluating learning of students. This will benefit us in effective use of time resources, talents and expertise.*

All the participants from the interviews verbalized the need for collaboration between the nurse educators and clinical personnel. This is supported by 100% of participants who identified nurse educators, and 100% of participants who identified nurse managers and professional staff as the key collaborators in implementing PBL.

This concurs with the report by Herrin, Hathaway, Jacob, McKeon, Norris, Spears, and Stegbaure (2006) in which it is documented that academic–practice collaborations are increasingly viewed as a requisite for the future of nursing and paramount to bridging education preparation and achievement of excellence in professional practice. Kirschling, and Erickson (2010) also indicate that collaboration assists in bridging the gap between nursing practice and academia and that it is a necessary prerequisite for assuring a qualified nursing workforce for the future and for positioning nurses to address emerging healthcare needs. The findings are also supported by Cave (2007) who describe that educators are far removed from practice and practitioners who are unaware of the relevance of theory to their work.

**Sub-theme 2: Interdisciplinary collaboration**

Inter-professional collaboration in implementing PBL in nursing education has been voiced by most participants. This was said by one participant

*If students from only one subject within the university are using PBL and other teachers from other departments are using traditional methods, it becomes a problem. Collaboration in use of PBL in all the subjects is needed. . Lecturers from department such as sociology, psychology, biology and social work may be very useful as partners in implementing PBL. I believe this will constitute interdisciplinary or inter-professional collaboration.*

This sentiment have been guaranteed by 100% of participants who were of the opinion that other departments like sociology, psychology, biology and social work should have be collaborative partners in implementing PBL.

These findings are supported by authors such as Pumar Mendez, Canga Armayor, Diaz Navarraz and Wakefield (2007); Derbyshire and Machin (2011); and Bennett, Gum, Lindeman, Lawn, McAllister, Richards, Kelton and Ward (2011) who highlight that inter-professional collaboration in education has potential to promote better understanding between the professions by encouraging students to engage in detailed exploration of health and social roles. These authors posit that inter-professional education has the potential to achieve greater collaboration between health care professionals, by encouraging greater understanding through creation of common knowledge base and culture.

### **Sub-theme 3: Inter-institutional collaboration**

Inter-institutional or inter-organizational collaboration as Fisher et al., (2009) put it “inter-institutional network can draw on and leverage organizations. The participants expressed the need for inter-institutional collaboration.

This is a quote from the participant

*And obviously other collaborators would be, but I can't give names, but could be champions of PBL.. I mean those universities that are long in the PBL game. (Educator)*

Nurse Manager said

*I think they must also be part of collaboration for purposes of mentoring and guidance in this PBL. They have agreed to mentor us for example. Uhm..... They invited us to their summer school or institute for PBL. They are willing to come over. Like they have just come not too long ago... Among others they helped us with issue of curriculum development.*

This was corroborated by n=95, 99% of participants who indicated the need for collaboration with centres of Excellence

These results are congruent with Crosby and Bryson (2010) who recommend that cross-sector collaboration in any public problem requires effective champions who will provide informal and formal leadership. Fisher et al (2009) also viewed inter-institutional network as a possible strategy to draw on and leverage the existing resources of multiple organizations. Although the literature was not specific to implementation of PBL, inter-institutional collaboration will benefit implementation of PBL in nursing education.

## **Theme 2: Opinions regarding the benefits in collaboration**

The word collaboration implies working together for the greater good, but it actually encompasses far more. Benefits of collaboration are for clientele (educational service and health care consumers); staff and institutions. The participants are of the opinion that collaboration is of benefit in many aspects. From this theme the following categories emerged: 1) Staff benefits; 2) students' benefits; 3) benefits for health care consumers; and 4) organizational benefits.

### **Sub-theme 1: staff benefits**

Participants perceived collaboration as beneficial for information and expertise sharing.

The following are quotes from participants:

*Growth in the sense that ... that... if we collaborate, we share information, then this will encourage research on the subject and contribute more, like we are doing now. This will increase the knowledge on the subject PBL. Is it not that currently we are collaborating with Canadian university which is kind of mentoring us on PBL curricular issues?*

*The nurse manager said*

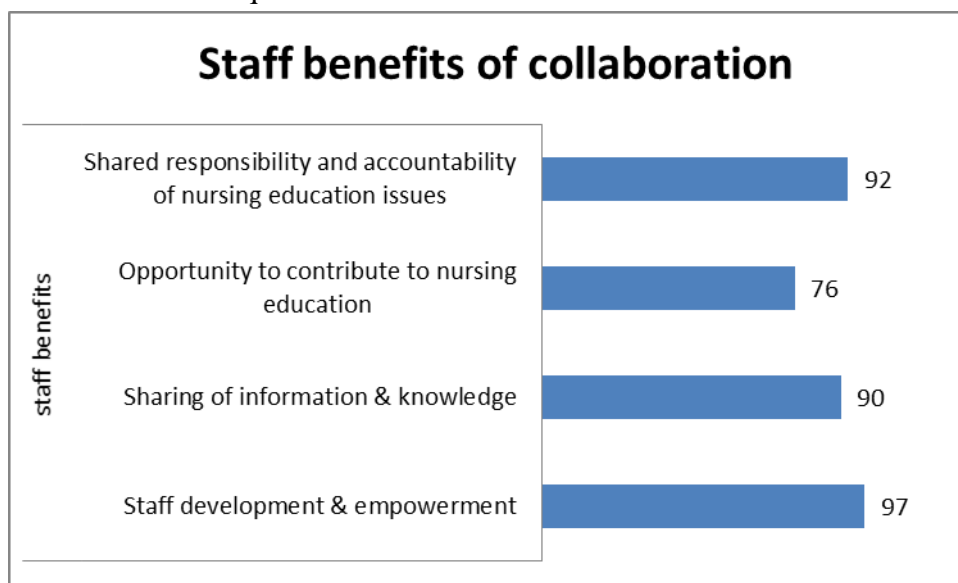
*This will also provide us with opportunity to contribute to the development of students and thus the profession.... We have nurses who specialized in different clinical course and may contribute in scenario development and evaluation of PBL students*

This quote is from one manager:

*Specialized nurses from different unit can be invited for scenario development, teaching in class and evaluation of students. Nurse educators or lecturers can come to the wards and clinics and address or equip the staff on PBL and other matters relating to nursing education. We would share time, talents and information resulting in effective use of available resources... .. and the blame game between academia and practice will be reduced*

This is supported by Lehna and Byrne (1995) who, in their study of collaboration between nursing education institution and hospice health care services, noted benefits of collaboration including increased theoretical knowledge and visibility, increased interest, participation and personal growth. They indicated further that educators will develop awareness of clinical requirements in the various settings (Lehna & Byrne 1995; AACN 1997; Brinkerhoff 2002)

The figure below corroborate the qualitative results



**Figure 2: Staff Benefits of Collaboration**

These findings support results of the study by Williams-Barnard et al (2006) wherein the practice nurses valued collaboration in nursing education in terms of increase in professional and intellectual stimulation, enhancing awareness of learning processes, sharing and building knowledge base for nursing education practice and continuing education. These authors also noted that sharing of one’s clinical competence provided the clinical nurses an opportunity to give back to the nursing profession

## **Sub-theme 2: student benefits**

Students as internal customers of nursing education and PBL will benefit from collaboration. Within the professional discipline of nursing, excellence in practice can best be attained when those in education and practice setting combine their efforts and talents in collaboration

The following were verbalized by participants

*If we (nurse educators and managers) collaborate, we will be part of students' clinical placement and problem/ scenario development, facilitation in clinical setting and evaluation. We will be able to identify correct periods for clinical placement and appropriate learning period in clinical services unlike presently when we just get an allocation lists already developed from the educational institutions.*

Nurse educator verbalized this

*In collaboration with other disciplines in PBL implementation including with the profession by collaborating as different disciplines in Nursing we will be socializing our student for real practice which require collaboration. They will learn by imitation. It is said what monkey see.. Monkey do. (Laughter and acknowledgement from the group)*

These statements are confirmed by quantitative results wherein participants indicated the following students' benefits in an open ended question.

1. Role-modelling of collaboration
2. Quality education
3. Supportive & nurturing learning environment

These findings concur with (Ardahan, Akcusy & Engin, 2010; and Brown, 2009) who in their study of interdisciplinary collaboration, students expressed more positive attitudes towards collaboration and helped in the development of awareness of team working and roles of each other. Student-Centred collaboration can be a functional reality in the delivery of quality education (Brown, 2009:54). These authors also suggest that collaboration can be used as a strategy to enhance active learning across disciplines and prepare students for collaborative interactions they will experience in future employment situations (Ardahan et al., 2010; and Brown, 2009).

Participants indicated that the students will benefit from expertise of the collaborators. For nursing education, students will benefit from expertise of collaborators as illustrated in this comment about this benefit:

*Specialized nurses from different unit can be invited for scenario development, teaching in class and evaluation of students. In this way, the students will be benefiting from expertise of both clinical and teaching staff. If we collaborate, the clinical staff will be involved in all curricular activities from planning of PBL curriculum, scenario development and evaluations.*

This concurs with Connolly and Wilson (2008) who found that students receive real world clinical instruction from competent and credible clinicians and service guaranteed students for clinical site, fostering recruitment into extern programmes and new graduate into positions

### **Sub-theme 3: organizational benefits**

Collaboration has the potential to benefit the partnering organization. Included are the following: 1) Sharing of resources and facilities, and 2) effective utilization of resources.

Participants expressed that collaboration in implementing PBL in nursing education would promote sharing of resources. The statements below depict sharing of resources as a positive outcome of collaboration:

*Um...generally, one would still say.... we have limited resources, especially in implementation. Like for instance, people would be having limited resources in people who are initiating or advancing the PBL itself. For instance, in clinical area,... if I may give example.... People might not necessarily have the relevant resource such time facilities as well as personnel with collaboration those gaps can be narrowed*  
(Nurse Educator)

Another quote

*I think as collaborators we will be able to share information and resources, both at individual and institutional level as well as team level. Institutions will share the limited resources and thus promoting effective utilization of the resources. Let us take for example the newly acquired simulation lab for PBL clinical learning*  
(Nurse Manager)

The findings are in line with those from an integrative review by Beal (2012) which reveals that collaborative partnerships enhance sharing of resources and facilities. According to Bleich, Hewlett, Miller and Bender (2004), who are regarded as thought leaders on topic of academic- service collaborative partnerships in nursing, the benefits that are cited by AACN in 1990 remain today. These include maximization of resources and sharing. The findings are supported by Fisher et al., (2009) on inter-institutional collaboration who viewed inter-institutional network as a possible strategy to draw on and leverage the existing resources of collaborating organizations.

Bentley and Seaback (2011) viewed inter-professional and intra-professional collaborations as imperative, particularly in the view of pending budget cuts for school of nursing. These authors in their study of faculty development with the use of collaboration in inter-professional collaboration found that outcomes of collaborative partnerships include regional sharing of resources and expanded collaboration between partners. Gitlin, Lyons and Kolodner (1994) endorse the view that collaborative and interdisciplinary teamwork is a way to overcome limited financial and personnel resources and to ensure that programmes and knowledge development are responsive to consumer needs.

### **Theme 3: Factors Contributing to a Successful Collaboration**

Modified D'Amour's et al.'s four dimensional collaboration model (2008) was used to guide the analysis of data related to factors sustaining and challenging collaboration in implementing PBL in nursing education. The following categories emerged from this theme (1) Governance /Leadership; (2) Shared goal and (3) communication and (4) formalization

### **Sub-theme 1: Governance**

D'Amour et al., (2008) are of the opinion that leadership is necessary for the development of inter-professional and inter-organizational collaboration

The following are the quotes from the participants:

*The nurse managers, especially at strategic position should be involved from the planning phase of problem based learning curriculum. They should be part and parcel of planning, implementation and evaluation of problem based learning.*

Another quote

*The heads of institutions, namely, the CEO of the hospital, the district manager, the nursing college principal and the head of department of nursing should agree to collaborate and kind of formalize this*

From the quantitative component n=93; 97% participants agreed that a clear commitment to collaboration working from most senior levels of management in confirmation of the above statement

These results are in line with Connolly and Wilson (2008), and Brinkerhoff (2002) who note that collaboration is beneficial when representatives from collaborating institutions are participating in strategic planning and evaluation of outcomes. According to Brinkerhoff (2002), senior management support contributes to collaborative partnership performance both directly and indirectly. Directly, such support translates into resource commitments (e.g., financial, personnel and others) and often entails flexibility and consequently maximizes performance. Indirectly, the participation of and support of senior management symbolizes the organizational commitment to collaboration and contribute to trust building among the collaborators (Brinkerhoff, 2002). Barnett et al., (2010) and Griffith and Crookes (2006) emphasize that strong leadership and genuine managerial commitment to work together are important to successful collaboration. With encouragement and support from senior levels of participating organizations, a platform of shared governance, collaborators are enabled to freely discuss and respond to related nursing education issues (Barnett et al., 2010).

### **Sub-theme 2: Shared goal**

A significant attribute of collaboration is that two or more individuals must be involved in a joint venture, typically one of an intellectual nature with a common goal (Henneman, Lee & Cohen, 1995; and AACN, 1997). The participants perceived having a common goal as leading to successful collaboration in implementing of PBL. These are the statements of participants:

*Common goal in collaboration is very important in any collaboration. In this instance, our common goal will be training a nurse through PBL implementation. If we have shared mission, vision and goals, our collaboration will be in the right direction. We must see the same hill and move toward it. This, I mean we must have a common goal as collaborators*

The other one had this to say:



*Yes, we must have one goal; have commitment to the goal and collaboration. We must respect each other, we must understand each other. This is very important in collaboration*

These results are supported by 98% of participants in the quantitative who agreed that a clear goal and vision shared by all is critical for a successful collaboration in implementing PBL in nursing education. This concurs with Patel et al (2012), Cao and Zhang (2011), D'Amour et al., (2008), Clarin (2007), Owen and Grealish (2006) and AACN (1997) who state that shared goals and vision must be established by collaborators. These authors suggest that the identification and sharing of common goals is an essential point of departure for a collaborative undertaking. A clear, common organizational and objectives can provide a framework within which to define collaboration strategies and goals; and determine the success of collaborative projects. Clearly defined goals provide a common ground for communication and structure about collaborative activities (Patel et al., 2012).

### **Sub-theme 3: Communication**

Successful collaboration is characterized by clear communication, true dialogue, active listening, an awareness and appreciation of differences and ability to negotiate options. Participants verbalized communication as a critical tool in any collaborative effort. The following is what one of the educators verbalized:

*Communication is a very important tool in any partnership. There must be open and regular communication between the collaborators. It can be through regular meetings, written communication, for example through memos, e-mails. But schedule meetings with clear agendas will contribute to success.*

This is what one manager said:

*If you are in partnership just like in marriage you must trust each other. You must be open. You must communicate now and then. Collaboration requires communication. Every now and then you must meet. There must be continuous feedbacks, workshops on this PBL. We want everybody to be on the same level about this PBL.*

Participants in quantitative survey reiterated the following themes in the open ended sections:-

1. Mutual trust and respect
2. Effective communications
3. Cooperation and
4. Teamwork

Literature (Owen & Grealish 2006; Jenerette et al 2008; Barnette 2010; Meunie- FitzHugh & Piercy 2010 and Patel et al 2012) confirms that communication promote collaboration. Cao and Zhang (2011) suggest that collaborative communication should be open, frequent, balanced, two way and multilevel. These authors emphasized both formal and informal communication as vital to collaborative partnerships. Lehna and Byrne (1997), in their successful collaboration between nurse educators and clinical practitioners at hospice, state that communication must be honest, respectful, and purposeful. Successful collaborative nursing education practice and collaborative health care practice need to encompass all of these conditions.

Communication in collaborative work underpins how people understand each other and how knowledge is transferred (Patel et al 2012).

Participants indicated the need for a non-hierarchical relationship that is characterized by mutuality for collaboration in implementing PBL to succeed. This is what was articulated by one nurse educator: *Eh...I think first of all recognition of status of each person and flattened hierarchy. No one should view himself as superior to the other, but relate collegially as partners.*

This perception is in line with Casey (2011), Owen and Grealish (2006), Harvarth et al., (2007); and Carnwell and Carson (ND) who viewed successful collaborative relationships as dependent on team oriented environment with non- hierarchical structures and the participants share decision making and common ownership of the resolution of challenges. Brinkerhoff (2002) refers to this as mutuality and included is equality in decision making, resource exchange, reciprocity (as opposed to hierarchical).

Equality or flattened hierarchical relations are likely to be another conscious strategy to nurture and strengthen collaboration in implementing PBL in nursing education.

#### **Sub-theme 4: Formalization**

In any collaboration, there must be an agreement about what problem is to be addressed and how multiple problems are to be prioritized (D'Amour et al., 2008). A variety of agencies and disciplines play unique, but overlapping, roles in nursing education.

The participants verbalized the need for a contract or a Memorandum of Understanding (MOU). This requirement was verbalized in different ways. Some referred to this as service level agreement, agency agreement and agreement contract

This was said by one nurse educator:

*If you are collaborating and there is an MOU, that can stipulate what is expected from the university side, what is expected from the hospitals side... we can get all cooperation.*

One nursing manager said in relation to formalization of collaboration:

*Generally, for collaboration to be formalized..... It's basically for people to come together. Either coming together or engaging new issues of LSA, that is, level of service agreement.... Where they would then understand as we work together, this is what I am expecting from this partner, and this is what I should be giving that particular partner or collaborator*

Ninety-five per cent (95%) of participants agree with this principle by indicating that each collaborators area of responsibility must be clear and understood. This is possible in a contractual agreement where the roles, responsibilities and tasks of each collaborating individual's, teams or institutions are detailed

These responses concur with the models by D'Amour et al., (2008), Clarin (2007), Owen and Grealish (2006) that advocate that formalization is an important means of clarifying the various partners' responsibilities and negotiating how responsibilities are shared. For professionals, it is important to know what is expected of them and what they can expect of others. This model also suggests that collaboration is influenced less by the degree of formalization than by the consensus that emerges around formalization mechanisms and the specific rules that are implemented. Edwards and Smith (1998) added by stating that

one helpful communication strategy has been to create “memos of understanding” from meetings or sessions. In a Memorandum of Understanding (MOU), key points of the discussions as well as the outcomes are noted. MOU (1) allows collaborators to agree on what was said or planned; (2) are effective in keeping everyone moving forward, up to date and on target (Edwards & Smith 1998)

### **Conclusions**

To educate health care workers of the 21<sup>st</sup> century, we need to work together in embracing participatory pedagogies such as PBL. The process of collaboration in implementing PBL in nursing education needs to be purposeful and objective, interactive, beneficial and time-framed. The following are critical in effective collaboration in implementing PBL 1) Having a clear articulated common goal lays the foundation upon which successful collaboration is build;2) commitment to collaboration must be established at a high level within educational and clinical institutions. 3) Joint planning which is interactive is a must. 4) Formalization of agreements documents with clear goals, roles, responsibilities and task should be in places; and 5) Communication processes and techniques need to be standardized during this stage.

### **Limitations of the Study**

A limitation of this study is the restriction of the study to nursing education of pre-registration programme, which implies limited generalizations. The sample of nurse managers and preceptors was confined to the North-West Province hospitals and clinics where PBL students are placed for clinical learning as compared to nurse educators from three South African universities offering PBL. This was attributed to the fact that clinical services used by participating universities to place their PBL students were far apart and very costly to get the managers together in terms of finances and time. The empirical data from nurse managers and preceptors were from one province, and there the findings can only be transferable within the province.

### **Acknowledgements**

The researchers acknowledge Atlantic Philanthropies for the generosity in funding PBL development at North-West University as well as participants for the rich information provided

### **List of References**

1. Albanese M.A (2000). Problem-based learning: why curricula are likely to show on knowledge and clinical skills. *Med Educ*; 39:724–38.
2. Alberto, J., & Herth, K. (2009). Inter-Professional Collaboration within Faculty Roles:Teaching, Service and Research. *OJIN: The Online Journal of Issues in Nursing*, 14(2)
3. Alessio, H. (2004). Student Perceptions about and Performance in Problem-Based Learning.*Journal of Scholarship of Teaching and Learning*, 4(1):23-34.
4. Alexander, J., Mcdaniel, G., Baldwin, M., & Money, B. (2002). Promoting, Applying, and Evaluating Problem-Based Learning in the Undergraduate Nursing Curriculum. *Nursing Education Perspectives*. 23(5): 248-253.

5. American Association of Colleges of Nursing (AACN). (1997). Education and Practice Collaboration: Mandate for Quality Education, Practice, and Research for Health Care Reform. *Journal of Professional Nursing*, 13(2): 129–133
6. Ardahan, M., Akcasu, B., & Engin, E. (2010). Professional Collaboration in Students of Medicine Faculty and School of Nursing. *Nurse Education Today*, 30(4):350-354
7. Arnold, S.A., Deans, C., & Munday, J. (2004). University and Service Sector Collaboration for Undergraduate Psychiatric Nursing Education. DOI: 10.1111/ J.1447-0349.2004.00309
8. Barnett, T., Cross, M., Shahwan-Akl, L., & Jacob, E. (2010). The Evaluation of a Successful Collaborative Education Model to Expand Student Clinical Placements. *Nurse Education in Practice*, 10(1):17-21.
9. Barrows, H.S. (2003). Generic Problem-Based Learning Essentials. [Http:// www. Pbli.Org](http://www.Pbli.Org) (Accessed 12 March, 2014).
10. Beal, J.A. (2012) Academic-Service Partnerships in Nursing: An Integrative Review. *Nursing Research and Practice*. Volume 2012.DOI:10.1155/2012/501564
11. Bedwell, W.L., Wildman, J.L., Diazgranados, D., Salazar, M., Kramer, W.S., & Salas, E. (2012). Collaboration at Work: An Integrative Multilevel Conceptualization. *Human Resource Management Review*, 22(2):128-145.
12. Bennett, P.N., Gum, L., Lindeman, I., Lawn, S., Mcallister, S., Richards, J., Kelton, M., & Ward, H. (2011). Faculty Perceptions of Interprofessional Education. *Nurse Education Today*, 31(6):571-576.
13. Brinkerhoff, J.M. (2002). Assessing and Improving Partnership Partnerships and Outcomes: A Proposed Framework. *Evaluation and Program Planning*. 25. 215-231
14. Brown, D.G. (2009). An Interdisciplinary Collaboration in Nursing Education. *Teaching and Learning in Nursing*. 4. 52-55.
15. Cao, M., & Zhang, Q. (2011). Supply Chain Collaboration: Impact on Collaborative Advantage and Firm Performance. *Journal of Operations Management*, 29(3):163-180.
16. Cape Higher Education Consortium (CHEC). (2004). *Guidelines to Systematic Collaboration in Western Cape Higher Education*. Cape Town: CHEC
17. Carlisle, C., & Ibbotson, T. (2005). Introducing Problem-Based Learning into Research Methods Teaching: Student and Facilitator Evaluation. *Nurse Education Today*, 25(7):527 541.
18. Carnwell, L., & Carson, A. (nd). Understanding Partnership and Collaboration. [www.Mcgraw-Hill.Co.Uk/Openup/Chapter/0335215371.Pdf](http://www.Mcgraw-Hill.Co.Uk/Openup/Chapter/0335215371.Pdf). Accessed 15th February, 2015
19. Carroll, J.K., Albada, A., Farahani, M., Lithner, M., Melanie Neumann, M., Sandhu, H., & Heather Shepherd, L. (2010). Enhancing International Collaboration among Early Career Researchers. *Patient Education and Counselling*. 80. 517–520
20. Casey, M. (2011). Interorganizational Partnership Arrangements: A Model for Nursing and Midwifery Education. *Nurse Education Today*. 31. 305-308. DOI.10.1016/J.Nedt.2010.11.011

21. Clarin, O.A. (2007). Strategies to Overcome Barriers to Effective Nurse Practitioner and Physician Collaboration. *The Journal for Nurse Practitioners*, 3(8):538-548.
22. Creswell, J.W., & Plano Clark, V.L (2011) Designing and Conducting mixed methods research. Thousand Oaks: Sage Publications
23. Connolly, M.A., & Wilson, C.J. (2008). Revitalizing Academic-Service Partnerships to Resolve Nursing Faculty Shortages. *AACN Advanced Critical Care*, 19(1):85-97
24. Crosby, B.C., & Bryson, J.M. (2010). Integrative Leadership and the Creation and Maintenance of Cross-Sector Collaborations. *The Leadership Quarterly* 21. 211–230.
25. Crossan, F. (2003). Research Philosophy: Towards an Understanding. *Nurse Researcher*.11 (1), 46-55.
26. Curtis, J. (2007). Working Together: A Joint Initiative between Academics and Clinicians to Prepare Undergraduate Nursing Students to Work in Mental Health Settings *International Journal of Mental Health Nursing* (2007) 16, 285–293 DOI: 10.1111/J.1557 0359.2007.00578.X
27. D'amour, D., Goulet, L., Labadie, J., Martín-Rodriguez, L.S., & Pineault, R. (2008). A Model and Typology of Collaboration between Professionals in Healthcare Organizations. *BMC Health Services Research*, 8(1):188.
28. Delva, M., Woodhouse, R., Hains, S., Birthwhistle, R., Knapper, C., & Kirby, J. (2000). Does PBL Matter? Relations between Instructional Context, Learning Strategies, and Learning Outcomes. *Advances in Health Sciences Education*, 5(3):167-177.
29. Derbyshire, Julie and Machin, Alison (2011). Learning to work collaboratively: Nurses' views of their pre-registration interprofessional education and its impact on practice. *Nurse Education in Practice*, 11 (4). 239
30. Dorner, J.L., Taylor, S.E., & Hodson-Carlton, K. (2001). Faculty-Librarian Collaboration for Nursing Information Literacy: A Tiered Approach. *Reference Services Review*, 29(2):132-141.
31. Drummond-Young, M., Noesgaard, C., Lunyk-Child, O., Maich, N.M., Mines, C., & Linton, J. (2010). A Comprehensive Faculty Development Model for Nursing Education *Journal for Professional Nurse* 26(3).152-161
32. Duch B.J., Allan, E.E., & White, H.B. (1998). PBL: Preparing Students to Succeed in the 21<sup>st</sup> Century. *Nurse Education Today*. 18(4): 356-361
33. Edward, J. & Smith, P. (1998) Impact of interdisciplinary education in underserved area: health profession collaboration in Tennessee. *Journal of professional Nursing* 19(2) 144-149
34. Eisingrich, A.B., Rubera, G., & Seifert, M. (2009). Managing Service Innovation and Inter Organizational Relationships for Firm Performance: To Commit or to Diversify. *Journal of Service Research*. 11 344-356.
35. Fisher, J.W.; & Kathryn E., & Peek, K.E. (2009). Collaborating For Change: Creating A Women's Health Network. *Women's Health*. 19. 3–7
36. Furber, C., Hickie, J., Lee, K., Mcloughlin, A., Boggis, C., Sutton, A., Cooke, S., & Wakefield, A. (2004). Interprofessional Education in a Midwifery Curriculum: The Learning through the Exploration of the Professional Task Project (Leapt). *Midwifery*, 20(4):358-366.



37. Gaskell, L. & Beaton, S. (2010). Inter-Professional Work Based Learning within an MSc In Advanced Practice: Lessons from One UK Higher Education Programme. *Nurse Education in Practice*, 10(5):274-278.
38. Gitlin, L.N., Lyons, K.J., & Kolodner, E. (1994). A Model to Build Collaborative Research Educational Teams of Health Professionals in Gerontology. *Education for Gerontology*. 20(1):15-34.
39. Greenwood, J. (2000). Critique of the Graduate Nurse: An International Perspective. *Nurse Education Today*, 20(1):17.
40. Griffith, R., & Croke, P. (2006). Multidisciplinary Teams. In: Dally, J., Speedy, S., And Jackson. D. 2006. *Context of Nursing*, 2<sup>nd</sup> Edition. Churchill Livingstone. 184-195
41. Gwee, M.C. (2009). Problem Based Learning: A Strategic Learning System Design for the Education of Health Care Professionals of 21<sup>st</sup> Century. *Kaohsiung Journal for Medical Science*. 25. 231-239
42. Haith-Cooper, M. (2000). Problem-Based Learning within Health Professional Education What is the Role of the Lecturer? A Review of the Literature. *Nurse Education Today*, 20(4):267-272.
43. Heatley, M., & Kruske, S. (2011). Defining Collaboration In Australian Maternity Care. *Women and Birth* 24. 53—57
44. Hendrix, C.C., Matters, L., West, Y., Stewart, B., & Mcconnel, E. (2011). The Duke – Niche Program: Academic-Practice Collaboration to Enhance Geriatric Nursing Care. *Nursing Outlook*. 59. 149- 157.
45. Henneman, E.A., Lee, J.L., & Cohen, J.I. (1995). Collaboration: A Concept Analysis. *Journal of Advanced Nursing* 21(1) 103-109.
46. Herrin, D., Hathaway, D., Jacob, S., Mckeon, L., Norris, T., Spears, P., & Stegbauer, C. (2006). A Model Academic-Practice Partnership. *Journal of Nursing Administration*, 36(12):547.
47. Horwath, J., & Morrison, T. (2007). Collaboration, Integration and Change in Children's Services: Critical Issues and Key Ingredients. *Child Abuse & Neglect* 3. 55–69
48. Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. In J. M. Spector, J. G. van Merriënboer, M. D., Merrill, & M. Driscoll (Eds.), *Handbook of research on educational communications and technology* (3rd ed., pp. 485-506). Mahwah, NJ: Erlbaum
49. Huxham, C., & Vangen, S. (2000). Leadership in the Shaping And Implementation of Collaboration Agendas: How Things happen in a (Not Quite) Joined up World. *Academy of Management Journal* 43(6)1159-1175
50. Jenerette, C. M., Funk, M., Ruff, C., Grey, M., Adderley-Kelly, B., & Mccorkle, R. (2008). Models of Inter-Institutional Collaboration to Build Research Capacity for Reducing Health Disparities. *Nursing Outlook*. 56. 16–24.
51. Johnson, R.B., & Onwuegbuzie, A.J. (2004). Mixed Methods Research: A Research Paradigm whose Time has Come. *Educational Researcher* 33(7), 14-26
52. Kinnaman, M.L., & Bleich, M.R. (2004). Collaboration: Aligning Resources to Create and Sustain Partnerships. *Journal of Professional Nursing* 20(5)310-322,



53. Kirschling, J.M., & Erickson, J.I. (2010). The STTI Practice– Academe Innovative Collaboration Award: Honoring Innovation, Partnership and Excellence. *Journal of Nursing Scholarship* 42, 286–294.
54. Koh, G.C., Khoo, H.E., & Wong, M.L. (2008). The Effects of PBL during Medical School on Physician Competency: A Systemic Review. *Canadian Medical Association Journal. CMAJ* 178(1) 34-41
55. Lehna, C., & Byrne, A.(1995). An Example of a Successful Collaboration Effort between a Nurse Educator and a Hospice Clinical Nurse Specialist/Director. *Journal of Professional Nursing.* 11(3):175-82
56. Mcwhirter, G., Courage, M., & Yearwood–Dixon, A. (2003). Diversity in Graduate Nursing Education: An Experience in Collaboration. *Journal of Professional Nursing.* 19 (3) 134-41.
57. Medley,C.F., & Horne, C.(2005). Using Simulation for Undergraduate Nursing Education. *Educational Innovation.* 44(1) 31-34.
58. Owen, J & Grealish, L. (2006) Clinical education delivery--a collaborative, shared governance model provides a framework for planning, implementation and evaluation. *Collegian* 13(3)15-21
59. Patel, H., Pettitt, M., & Wilson, J.R. (2012). Factors of Collaborative Working: A Framework for a Collaboration Model. *Applied Ergonomics.* 42. 1-26. Doi/10.1016/J.Apergo. Accessed 2015.04.09.
60. Pumar Mendez, M.J., Canga Armayor, N., Diaz Navarlaz, T., & Wakefield, A. (2008). The Potential Advantages and Disadvantages of Introducing Inter-Professional Education into the Health Care Curriculum in Spain. *Nurse Education Today.* 28. 327-336
61. Reynolds, F. (2003). Initial Experience of Inter-Professional Problem Based Learning: a Comparison of Male and Female Students. *Journal of Inter-Professional Care* 17(1) 35-44
62. Rideout, E. (2001). *Transforming Nursing Education through Problem-Based Learning.* Toronto: Jones & Barlett.
63. Savery J.R. (2006). Overview of Problem Based Learning: Definitions and Distinctions. *Interdisciplinary Journal of PBL* 1 (1)
64. Schifferdecker, K.E., & Reed, V.A. (2009). Using Mixed Method Research In Medical Education: Basic Guidelines for Researchers. *Medical Education* 43. P637-644.
65. Souers, C., Kauffman, L., Mcmanus, C., & Parker, V. (2007). Collaborative Learning: A Focussed Partnership. *Nurse Education in Practice.* 7, 392–398
66. Vangen, S., & Huxham, C. (2003). Nurturing Collaborative Relations: Building Trust in Inter-Organizational Collaboration. *The Journal of Applied Behavioral Science,* 39 (1), 5-31.
67. Walter, I., Davies, H., & Nutley, S. (2003). Increasing Research Impact through Partnerships: Evidence from outside Health Care *Journal of Health Services Research and Policy,* 8 (2), 58-61
68. Williams, S.W., & Beatti, H.J. (2008). Problem Based Learning in the Clinical Setting: A Systematic Review. *Nurse Education Today,* 28, 146-154. DOI: 10.1016/J.Nedt. 2007.03.007.