Poovendhree Reddy
Department of Community Health Studies, Discipline of Environmental Health, Durban University of Technology, P.O. Box 1334, Durban, 4000, South Africa

DOI: http://dx.doi.org/10.18820/2519593X/pie.v36i1.4
ISSN 0258-2236
e-ISSN 2519-593X
Perspectives in Education
2018 36(1): 44-62

Research methods for undergraduate delivery: Evaluation of problem-based learning

Abstract

Research methods are considered a complex and difficult subject to teach and there is limited data on innovative ways to teach it to undergraduate public health professionals. Although problem-based learning (PBL) is a common approach in various disciplines, little is published on its use in developing research skills within the South African context. This paper outlines the delivery of an undergraduate research methods course with an evaluation of the problem based learning approach with respect to student experience and competence.

A cross sectional descriptive case study was conducted among the students of Environmental Health within the Faculty of Health Sciences at the Durban University of Technology. All students enrolled for 2015 were invited to participate. Questionnaires were administered after each section and at the end of the Research Methods course. Participants were required to recall how they experienced different sections of the course and to self-reflect on perceived competency post-delivery.

Participants reported that they benefitted from the PBL approach and indicated that independent learning helped to develop skills that they could transfer to their professional environment. They enjoyed group interactions and private consultations with the instructor, but expressed difficulty with the literature review, choosing and summarising relevant information and statistical concepts and terminology. The final proposal was a 'light bulb' moment and participants successfully converted their research problem into a proposal. Problem-based learning may be used as a successful strategy for skills development in research methods courses.

Keywords: *Research methods, problem-based learning, research methods instruction, undergraduate research, self-directed learning*

1. Introduction

Many consider research methods courses a complex domain that confounds students and academics alike (Lehti & Lehtinen, 2005). Instructors have the unenviable task of transferring the complexities of these concepts to students who are completely new to the research process (Earley, 2014). However, in spite of significant interest in promoting research skills among postgraduate students, there is limited data for undergraduate students (Lombard & Kloppers, 2015). The national development plan (National

Planning Commission, 2013) is a policy imperative in South Africa which stresses the need for substantial growth in postgraduate training in order to move South Africa from a resource-based economy to a knowledge-based economy (Sonn, 2016). Higher education is under pressure to produce more postgraduates, but research remains a daunting prospect for many, and motivating students to undertake postgraduate studies may be dependent on their confidence in research methods. It is thus imperative that research skills are effectively introduced and strengthened at the undergraduate level.

Wagner, Garner and Kawulich (2011) reported that only a few systematic studies related to curriculum design and the teaching of research methods exist. In addition, facilitators of research methods courses have to rely on their own research experience, substantive literature, and student feedback/performance to improve delivery. The research discourse is complex and students often struggle with conceptualisation and understanding of concepts and the way they fit together in the final product. Students are required to integrate skills together with research and discipline-specific knowledge to answer a question in a scientifically rigorous manner. The approach of problem-based learning (PBL) is an instructional method in which students learn through facilitated problem solving. Problem-based learning is a generally accepted approach to learning in health care curricula, particularly for clinical instruction. The instructor has a pivotal role to plan, guide and supervise learning in the PBL approach. The goals of PBL include helping students to develop knowledge, effective problem-solving skills, self-directed learning skills, effective collaboration and intrinsic motivation (Hmelo-Silver, 2004; Carlisle & Ibbotson, 2005). Biggs (1999) asserts that “good teaching” is achieved when most of the class is thinking at the level of the more intelligent students, so the challenge is to enable the majority of the class to engage at a higher cognitive level. Critical thinking and independent learning are phrases that have been linked to PBL particularly where students were asked to formulate problems and then equipped with skills to solve these problems (Kemp, 2011). PBL involves interacting with learners, with focus on the starting knowledge that each student brings to the PBL process and allowing the student greater control in terms of the direction and content of learning (Richardson, 2003). This strategy is linked to the constructivist theory of learning, which is based on the principle that learning is not passively transmitted by direct instruction; it is achieved by the students’ activities, experiences and ability. The constructivist method of PBL is particularly popular in health sciences instruction, where learning is fostered through discovery (Kemp, 2011).

The current format of Research methods 4 in the Environmental Health programme actively engages students in participative exercises. The course journeys tentatively, outcome by outcome, into the research process by providing students with practice in each competency. The assessments are iterative and cumulative, leading to a research proposal at the end of the course that is prepared using a postgraduate template. My primary objective in teaching the research methods course has been to develop student’s critical thinking and practical skills in research. It is all about the “what, why, when, where, who, how and so what” questions. Simplifying a complex research problem to a few questions facilitates learning; i.e. *what* is the problem, *why* is it important to investigate, *when* do you want to do the project, *where* is the proposed study site, *who* are your participants/sample, *how* will you do it (methods) and *what* is the proposed outcome/importance? However, what exactly are students learning? Are the students going through the motions just to pass the course or do a few reach the ‘light bulb’ moment of understanding the concept of research?

Although PBL is a common approach in various disciplines, there is little published on its use in developing research skills, particularly in the South African context. This paper outlines the overall delivery of a PBL undergraduate research methods course with an evaluation of student experience and competence.

2. Method

A cross sectional descriptive case study of the Research methods 4 undergraduate course in the Bachelor of Technology: Environmental Health Programme within the Faculty of Health Sciences at the Durban University of Technology (DUT) was carried out. All students enrolled in 2015 were invited to participate (n=40). Participation was voluntary and all participants signed informed consent (n=37). The DUT Institutional Research Ethics Committee approved the study.

Students were directed with respect to a topic selection by allocation of a Sustainable Development Goal (SDG) (United Nations Development Programme, 2017) at random. The student was tasked with finding an area of interest within the given SDG. A student, for example, allocated SDG3, chose a topic related to the use and availability of water and sanitation in relation to health outcomes within an informal settlement. SDG3 relates to ensuring healthy lives and promoting wellbeing for all at all ages. It was mandatory that all topics were related to the field of environmental health. With guidance from the instructor, all the proposed topics and aims were discussed and finalised in a one-on-one session. The topics were deconstructed throughout the course. The student was required to prepare a literature review, methodology, ethics documents and data collection instruments. The goal was that each assignment would lead up to the final proposal. The course outline, with the various learning activities and associated assessments, is presented in Table 1. Apart from five formal assessments, small learning activities (as denoted in Table 1) were given after each section to facilitate understanding. In addition, the instructor was available for individual consultations and evaluation of drafts. Additional resources related to each section were provided in an online classroom.

2.1 Data collection

Questionnaires were piloted to ensure content validity and reliability. The instructor was not present during questionnaire administration and was blinded to student identifiers. An open-ended questionnaire was administered to all participants at the end of each section (Table 1) to evaluate their perceptions and understanding of that section. A summative questionnaire was administered at the end of the course. Participants were required to recall how they experienced different sections of the course. Perceived competence with research skills was also evaluated. The summative questionnaire was developed with consideration of the learning outcomes and competencies as described in the course syllabus. Questions included student reflections on learning and understanding of research concepts. This included the development of effective search strategies and skills in order to identify and locate appropriate sources for articulating research topics; preparing a literature review with annotated bibliography; engaging with quantitative and qualitative methodologies; ethics in research; statistics and data analysis; understanding of the research process; proposal development; and, overall experience and perception of the course. Data from open-ended questions was content analysed for emerging themes. Students were required to rate each assessment for difficulty from 1-5 (where 1=easy; 2=moderately easy, 3=average, 4=difficult

and 5=most difficult) and a mean score was calculated from student ratings. Summary statistics (mean, median, range) for student assessments were calculated. STATA (version 12) was used for quantitative data analysis.

Table 1: *Research methods course outline with associated activities and assessments

Session	Learning outcomes	Teaching and learning activities*	Assessment
The research process	The student should be able to define basic research concepts and explore various research designs; The student should be able to develop and frame ideas or questions into aims and objectives; The student acquire skills to search for scientifically valid literature using various databases; The student will be familiar with reading scientific literature and extracting information; The student should be able to write a literature review and reference appropriately.	On first contact student was given a Sustainable Development Goal (SDG) that was allocated at random. They were given time to read and formulate a topic of interest. For example, SDG 11: Make cities inclusive, safe, resilient and sustainable was used to formulate a topic around the effects of the KwaZulu-Natal (KZN) drought and water conservation practices among the urban community. Instructor discussed topics and aims individually with each student. Students were given journal articles and instructed to prepare a summary in their own words. Class work activity: use referencing guidelines to reference a given set of articles. Students given an example of a literature review and referred to the institutional repository to access masters and doctoral theses and dissertations as examples. Training on the use of online databases was provided by the library.	Each student submitted a 10-page literature review related to their topic. A list of references was included and prepared according to the Harvard format as per institutional guidelines. Assessed using a rubric.

Session	Learning outcomes	Teaching and learning activities*	Assessment
Methodology	The student should be able to evaluate ethical issues as pertaining to different research scenarios; The student is able to understand the challenges and advantages of qualitative and quantitative methodologies; The student learns the basic principles of qualitative data analysis; The student should be able to acquire basic skills to set up and conduct interviews and focus groups; and The student acquires skills to formulate questionnaires and focus group questions.	Instructor used a single study topic to teach the various topics on methodology. Students were given a group activity to design a questionnaire on a given topic. This was peer reviewed and critically evaluated by other groups in the class. Focus group held with students as participants. Class discussion following focus group. Ethics case study given. Students were required to engage critically with the real-life case with respect to all ethical principles taught.	Students were required to provide a detailed plan for their proposed methodology according to the following: Study area Study population Sampling strategy Data collection Ethics consideration They were required to prepare an informed consent and information sheet for their potential study group. Based on their proposed methodology, a complete questionnaire and/or a set of focus group questions were designed. Rubrics used.
Data analysis	The student understands how to deal with research data; The student understands basic statistics terminology; The student should be able to distinguish and apply descriptive and some inferential statistics; and The student is able to use Excel to do graphs and basic statistical analysis.	This was theory and practical session combined. Students were required to complete exercises on MS Excel after each section was delivered. A detailed classwork exercise was given to ensure that students had understood and learnt skills	Students were given data sets in Excel format and a set of questions related to the data. Classwork was evaluated. A research methods test that was heavily weighted in biostatistics was given.

Session	Learning outcomes	Teaching and learning activities*	Assessment
Proposal writing and dissemination	The student can structure a complete research proposal. The student acquires the skills required to prepare research related budgets. The student is able to develop scientific writing skills for proposal and report writing. The student recognises the various routes of disseminating research results. The student is able to communicate research ideas effectively to a peer audience.	Group work and critical review. Several examples of good and poor proposals were given to groups. The contact session was followed up with one-on-one advisory meetings with students to evaluate progress with proposal. Comment on drafts.	Students were required to submit a completed research proposal with all attachments (methodological instruments and ethics documents). The research proposal was assessed using a rubric. Oral presentation of proposal using PowerPoint.

*Contact sessions with the instructor was held for each session and online readings and resources were provided

3. Results

Of the 40 students enrolled for the course, 37 completed both questionnaires. Most participants were female (65%) with 81% African and 19% (7) Indian. Approximately 73% were part time students. Themes were identified from the collective answers provided for open- ended questions (Table 2). Participants reported that the section on preparing a literature review helped them to understand how to access and deconstruct peer reviewed literature. They acknowledged that the classwork exercises facilitated learning. Participants valued the personal development and the skills transfer such as independent learning scientific writing and reading during this section as the following student quotation suggests:

> *…being able to work on my own and reading up on topics that were related to my study was challenging but helped me to grow. Doing the final literature review was proof of how much knowledge I had gained pertaining to my study topic (Participant 3).*

Some participants reported that referencing and scientific writing was challenging and they found difficulty with selecting relevant information with respect to their topics.

Most participants enjoyed the section on methodology. A general methodology plan was provided with guiding subheadings that were structured and simple to follow. In addition, participants were handed a group-work task to formulate a questionnaire on a given topic, which was subsequently peer reviewed and discussed in class. Participants enjoyed these teaching strategies. Solving the problem or 'puzzle' through a well-developed methodology enhanced understanding and participant competence. Participant 4 described her experience with this section:

> *The given questions or breakdown related to methodology gave me clarity about my topic…it was more practical and made me understand all the steps required to conduct a study (Participant 4).*

Although some participants enjoyed the opportunity to apply learning, others found it challenging to customise the theoretical concepts of methodology to their respective topics. Participants requested additional learning time for methodology with both good and poor examples of methodology to review in class. Many participants reported that the skills learnt during the section on data analysis and statistics was very useful in teaching them how to analyse data and use MS Excel, but they had difficulty with the statistical discourse in terms of understanding and applying terminology. Many participants could not cope with the pace and it was evident that additional time should be allocated to this section as illustrated by the excerpt below:

> *need to allocate more time.. All the information at once was overwhelming and confusing. We need a theory class before the practical session as most of us aren't familiar with terms and the use of Excel (Participant 29).*

The proposal writing and dissemination session was both challenging and rewarding for participants. Competence in research was developed as they began to identify the links with topic, aims and methodology. As one student explained:

> *..now I am able to link my objectives with the methodology that I need for my study, it made me understand that in future, we will be able to write our very own proposal and budget going forward (Participant 36).*

In addition, most of the work was already done in previous assessments and they could concentrate on building the final proposal. Individual supervision in this phase was beneficial. Participants enjoyed learning from dissemination of research by oral presentations. Watching their peers present their own projects further enhanced their own understanding of multifaceted research. Participants developed various skills during this session, including resource utilisation and self-awareness. Additional student responses related to each session are included in Table 2. The post-course survey required participants to evaluate aspects of the PBL approach, their perception of skills learned, and overall experience of the course using a 4-point Likert scale (Figure 1). While the majority of participants agreed that the teaching and learning strategies were successful, 30% of participants did not like being directed towards a research topic based on a SDG goal. Participants' perception of skills acquired during the course is presented in Figure 2. Most participants felt competent with aspects of methodology and ethics but 69% did not understand all the concepts of statistics. In addition, some reported a limited perceived competence in searching for relevant literature (47%), evaluating useful sources (25%), and writing a literature review (36%). It was interesting to note that even though 86% agreed that they were able to turn a problem into a research question, only 32% were confident with preparing aims for a particular topic. Figure 3 shows overall evaluation of student experience of the course. Most participants enjoyed the teaching style (66%) and instructor facilitated learning (97%). It was encouraging to note that all participants understood how the various pieces fit together to form a research proposal, and many indicated that they may consider enrolling for a Master's degree in the future. Participants' rating of assessment difficulty and actual mean scores are presented in Table 3 (ranging from 1-5 in terms of difficulty). Participants rated the assessments for the literature review and the statistics/test to be most difficult (3.8 and 3.6 respectively). This was reinforced by the actual mean scores from student assessments with the literature review (57.1) and statistics test (54.8) having the lowest means when compared with other assessments.

Table 2: Participant responses to open-ended questions after each completed section

Section	Question	Theme	Student response
Literature Review	How was the session useful?	Accessing and deconstructing journal articles.	*"Learning how to obtain journal articles from databases. It also gave us an understanding of how a lit. review should be structured correctly and taught me how to reference correctly."*
		Link to student topics	*"reading of the variety of articles, made my topic easier to understand and increased my knowledge of my topic."*
		Instructor controlled learning.	*"the explaining of the work or exercises by the instructor about how to do a review the correct way and giving us access to read other reviews done."* *"examples made in class, marking other classmates work."*
	What did you enjoy most?	Personal development	*"Reading other people's thesis. It opened my mind."* *"Being able to work on my own."* *"Being part of the class because some of the things/ information that she taught us were useful when you go back to workplace."* *"Doing the task as it was challenging but it helped me grow."*
		Skills development	*"Looking up for journals that related to my topic and learning how to search for journals."* *"Reading different articles because it helped in enhancing my English grammar and also how to reference properly."* *"Doing the final write-up of my literature review, it was proof of how much knowledge I had gained pertaining to my study topic."* *"Conducting research to complete my literature review as it gave me insight on many other aspects that are linked."*
	What did you find challenging?	Issues with referencing	*"Referencing. I found it hard to reference what has been referenced already. Putting together other people's ideas without adding my own was a bit challenging."*
		Sifting through information	*"Not knowing what to include or exclude in your assignment."* *"Grouping relevant information together when doing my write- up."*
		Scientific writing	*"Time is not enough to prepare. The language sometimes is too scientific."* *"I found it a bit difficult to stick to writing in scientific language for the entire lit. review."* *"Making my literature flow. I couldn't get it into the point where I wanted to be."*
	How may we improve the session?	Teaching strategies	*"Getting more examples of other people's lit. review."* *"Give more practice in class, in groups then individually for assessment."* *"Giving us a bad example of a lit. review in class. Go through it with us. Give correction for all the errors. Give tips on how to improve it which will in turn help us to use those tips and corrects in our own lit. reviews. I find it helpful to learn from mistakes that others make so I know how to improve my own work."*

Section	Question	Theme	Student response
Methodology	How was the session useful?	Teaching strategies	*"How you can try and solve the puzzle through questionnaires."* *"Working in groups at first helped and made it easy to attack my own methodology."* *"Going over other students work and doing corrections."* *"The methodology plan made it easier to understand."*
		Development of student competence	*"One made me understand all the steps required in order to conduct a study."* *"I now understand the different sections that must be included in the methodology. The detailed description of how the questionnaire should be structured was very useful."*
		Applied learning	*"Having to take what I learnt and apply it on my work. That was interesting."* *"Compiling questionnaire for my proposed methodology as it prepares me for Masters."*
	What did you enjoy most?	Teaching strategies	*"The fact that sections were broken down and made easy to understand."*
	What did you find challenging?	Customising methodology	*"Choosing the types of study designs to use and understanding the study designs."* *"Writing for my participants who are the elderly. It was challenging to use language so that they could understand."* *"Study population, as it was difficult for me to calculate my sample population."*
	How may we improve the session?	Teaching strategies	*"More time on methodology."* *"Getting more examples of other people's methodology."* *"If there could be more group work tasks."* *"Past year assignments or examples of the methodology assessment should be distributed in class and should be discussed on how it should be done in terms of what's the right way of doing it and what's the wrong way."*

Section	Question	Theme	Student response
Data analysis and Statistics	How was the session useful?	Skills development	*"I am able to use Excel to analyse data. I am now able to calculate statistics with a better understanding."* *"You can also use it elsewhere, not limited to class."*
		Instructor controlled learning.	*"The practical work of literally doing the work on Excel as Prof. taught us was very useful in helping me to understand better."*
		Critical reflection	*"it makes it able to summarise data. Enables you to analyse information and opens your mind."* *"Challenging, make one think critically and diverse."*
	What did you enjoy most?	Practical skills development	*"Working on Excel as I learnt new things."* *"Yes, it gives me knowledge on how to present my findings after completing a study and the easy ways of verifying my studies."*
	What did you find challenging?	Difficulty with statistical discourse	*"Some of the terminology and keeping up."* *"First class where I had to juggle understanding words and use of Excel."*
	How may we improve the session?	Pace and time constraints	*"Keeping up to speed with the lesson as there was a lot to take in at once."* *"Grasping everything, understanding everything in a short space of time."*
		Additional time	*"Introducing the statistics early during the course of the year and have about 3-4 lectures for these sessions."* *"Stats can be very confusing so I feel the session should be extended to more than 2 days so that the pace of teaching and learning is slower allowing students to understand better instead of being lost."*
		Teaching strategies	*"More questions to do, this will improve learning experience."* *"Familiarising myself with terminology… prior to the lecture, having key terms given to me to read."* *"first having a theory class before the practical session as most of us aren't familiar with terms and how to use Excel."*

Section	Question	Theme	Student response
Proposal writing and dissemination	How was the session useful?	Development of student competence	*"I was able to see and understand the relationships between the methodology and the aims and objectives."* *"The session was always useful because the information that we get was also contributing in my workplace."* *"you get used to presenting in front of your classmates"*
		Instructor supervision and support	*"The private consultation with instructor was also useful in ensuring that one included everything required."* *"The template given to us made it easy to understand what to focus on… gave us structure."*
		Learning from dissemination	*"Standing in front of my peers and rendering my proposal to them and also to critique other people's proposals."* *"Others presentation makes one see the gaps one has."*
	What did you enjoy most?	Skills development	*"The researching and gathering information part of it. I really enjoyed exploring my topic and learning new things."* *"Learning on my own using the resources available online."* *"Reviewing and improving my past work."*
	What did you find challenging?	Methodology in proposal preparation	*"Understanding the study design in terms of applying them to my study as well as statistics."* *"Compiling data analysis section, but the instructor noted my wrongs and I was able to elaborate on them to do better in future."*
		Summarising previous literature review	*"Summarising my literature review."* *"Deciding what to include and exclude."*
		Presentation skills	*"Being able to present data which is sufficient enough within a short space of time."*
	How may we improve the session?	Increased number of lectures	*"Although there were consultation times allocated, I believe if possible to have more sessions/lectures to ensure that we understand."*

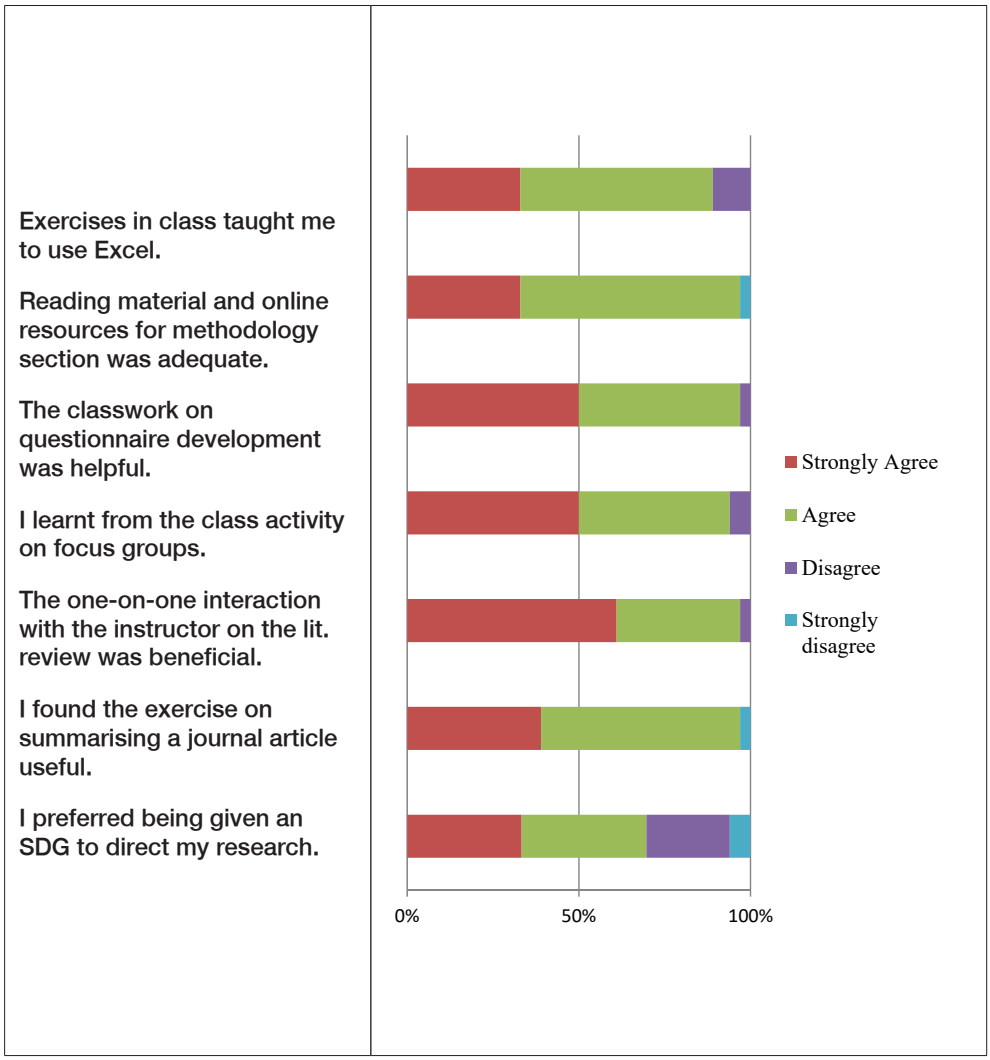

Figure 1: Responses of Research methods 4 participants regarding the teaching and learning practices used (n = 37)

I completed the classwork with ease.

I understood the concepts in statistics.

I know the difference between quantitative and qualitative methods.

I am able to prepare informed consent for a research project.

I understand the importance of ethical research.

I know how to construct a reference list.

I know how to reference in-text.

I understand the concept of plagiarism.

I am competent at writing scientifically for a literature review.

I know how to use information from journal articles to write a literature review.

I know how to evaluate if literature sources are useful or not.

I had difficulty finding journal articles relevant to my topic.

It was the first time I read a journal article.

I can prepare aims for a particular topic.

I know how to turn a problem into a research question.

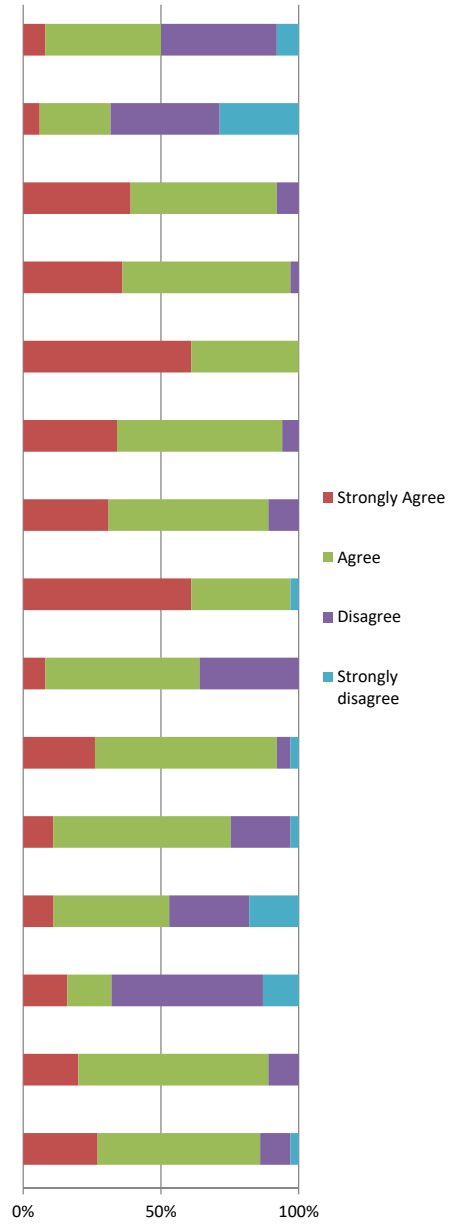

Figure 2: Participants' perception of skills development during the Research methods course (n = 37)

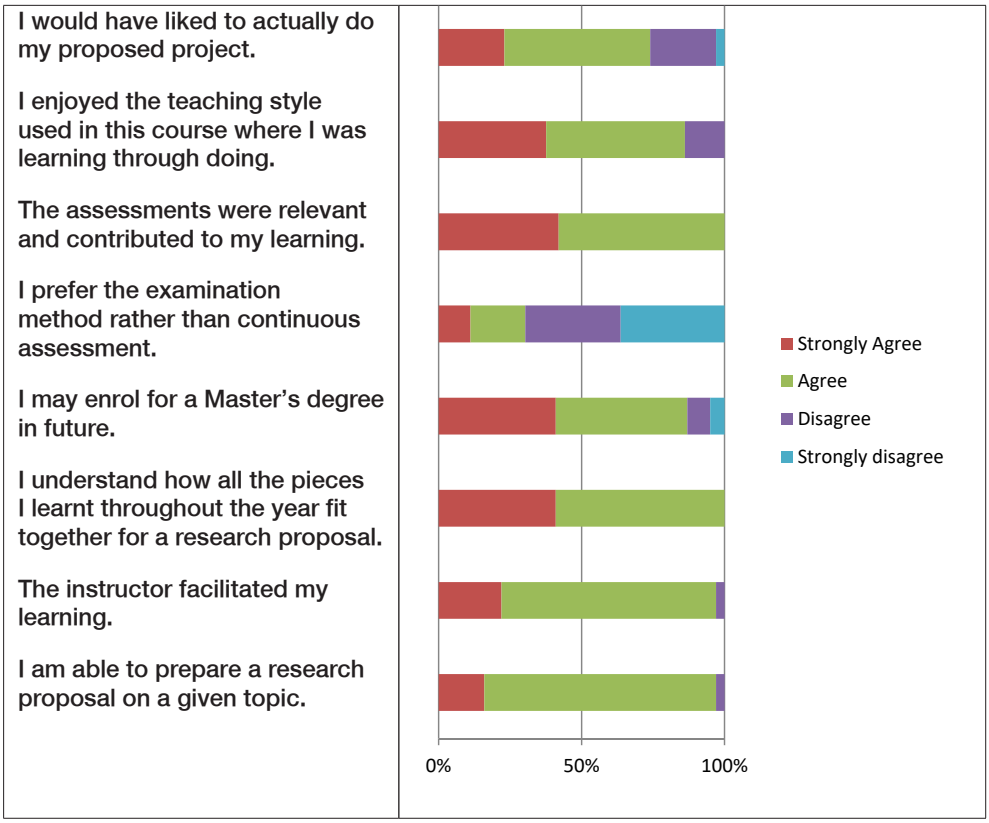

Figure 3: Overall evaluation of Research methods 4 (n = 37)

Table 3: Participants' ratings and achievement in Research Methods (n = 37)

Assessment	Mean Rating*	Student Achievement
		Mean (SD) Median Range
Literature Review	3.8	57.1 (11.9) 53.5 32-80
Methodology	2.5	64.2 (15.1) 63.0 37-93
Statistics/Test	3.6	54.8 (13.9) 55.5 28-87
Presentation	2.6	70.2 (7.1) 69.5 54-89
Proposal preparation	3.2	64.7 (10.8) 64.5 40-91

*Ratings from 1–5 where 1 = easy and 5 = very difficult

4. Discussion

Research methods is a difficult course to teach at the undergraduate level and requires that the instructor reach into the teaching and learning toolkit to find innovative strategies to impart knowledge and skills related to a complex discourse. Although PBL is a common approach in various disciplines, there has been little published on its use in developing undergraduate research skills. This study evaluated student experience and competence using PBL as a teaching paradigm for a research methods undergraduate course. Participants generally benefitted from the PBL approach and felt that independent and critical learning helped develop skills that they could transfer to their professional environment. Participants reported difficulty with statistical concepts and terminology although they enjoyed the practical component. The final proposal was a 'light bulb' moment and participants successfully converted their problems into proposals.

The Research methods 4 course is skills based to enable students to be intelligent users of research and to effectively design, implement and interpret projects in their professional lives. However, in my experience of teaching Research methods 4 over 10 years, it would appear that most students dread the course and find it abstract and difficult. A facilitator needs to address these concerns while ensuring that the course is relevant, current and broadly focused enough to hold the interest of students specialising in the various fields of environmental health, while also stimulating independent learning and an interest in research. This is a daunting prospect for the instructor, particularly as it involves supervising the progress of over 40 completely different research project proposals from novice students.

Different methods of delivery for research methods have been explored within the context of the Faculty of Health Sciences at DUT. The first strategy was that all students across various disciplines were combined and academics with appropriate expertise were then assigned a particular topic e.g. qualitative research. Unfortunately, this met with limited success as the students failed to connect research content with their discipline areas. In the subsequent model, each student was required to design, execute and report on a mini research project within a very short space of time (about 10 months). The format of delivery and assessment was then modified within our programme to ensure that students are equipped with the necessary tools and skills to identify a problem and locate practical solutions in a systematic way. The research proposal is the final outcome, so that students learn each new research related skill, and then test their abilities by fitting together the pieces of a jigsaw puzzle into one coherent proposal.

As far back as 1975, research methods instructors have recognised that "being able to do research is a skill consisting of both knowledge and practical decision-making competence" (Earley, 2014). A review of literature on various prescribed approaches to teaching research methods showed that international universities have significant emphasis on training students to conduct research (Wagner *et al*., 2011). There are various methods employed by universities to transfer research method skills to students but there is no obvious 'one size fits all' strategy. While current research teachers have access to expansive literature explaining research methods, the jury is still out on the most effective teaching and learning styles of concepts (Wagner *et al*., 2011). The PBL approach may be well suited for delivery of research methods. During PBL, the students themselves describe the context, develop and construct the problem given minimal direction. This strategy encourages the "how to learn" as well as decision-making about "what to choose" (Carlisle & Ibbotson, 2005). Students are engaged

with using their research question or problem to unpack each component of the proposal writing process. They journey tentatively, outcome by outcome, into the research process by formulating a research question; conducting a literature review; devising a methodology to address the research question; data analysis; dissemination; and, proposal writing. Formative exercises are given after each section to evaluate understanding. The final product or 'solution' is a scientifically rigorous research proposal. Such instructional strategies challenge students to solve 'authentic' problems and acquire complex knowledge in information-rich settings based on the assumption that having students construct their own solutions leads to the most effective learning experience. Problem-based learning also develops 'soft skills' such as scheduling and planning of tasks, organising and summarising information, and reading and analysing literature (Kirschner, Sweller & Clark, 2006).

In this study, the initial contact session, where the participants were directed with respect to developing their topics and aims, was useful in fostering an early 'supervisory' relationship between instructor and student. This allowed for an ongoing collaboration where the student was comfortable with 'exposing their flaws' to the instructor. I reinforced the notion that the research question and design should only be as complicated as is necessary to answer the research question. Participants were introduced to peer reviewed literature and database searching which proved useful in understanding their own topics. The realisation that every journal article was 'someone's actual research project' was discussed in class. Participants found that peer assessment of actual examples of literature reviews were very helpful. They wanted examples of 'bad' literature reviews so that they could learn from them. Developing a critical balanced literature review was a difficult task for participants. This is an essential skill as Tashakkori and Teddlie (2003) reported that students develop an appreciation for the changing landscape of knowledge construction and are able to see how a hypothesis is supported in one study but may be refuted in another.

Competence was developed by guiding participants to develop the methodology in a stepwise method. Students were encouraged to engage with other proposals and dissertations that showcase various research constructs which enabled them to connect theory with reality. It was interesting to note that participants once again applied this learning to their professional work environments. While undergraduate students should understand basic statistics for a given set of data, they should not be expected to derive statistical formulae. In general, students are more receptive to a discussion of concepts with relatable examples. Authors agree that statistics may dazzle students with jargon and rhetoric and tend to emphasise data analysis rather than the process (Denham, 1997; Ryan *et al*., 2014). In this study, theory and practical was directly linked in the methodology section, and the participants enjoyed learning MS Excel with the use of practical data analysis examples. Apart from skills development, the participants also felt that the session challenged their ability to evaluate information or data critically. However, participants had difficulty with complex statistical discourse and jargon, finding it hard to keep up with the terminology, concepts, problems and practicals at the same time. Participants suggested that we improve this section by including additional time and offering pre-stats lectures that introduce terminology in preparation for the statistics session. The section on proposal writing and dissemination was the 'light bulb' moment for participants, where they were able to link concepts together to form a rigorous research proposal.

PBL was used to organise the curricular content around problem scenarios and the student was guided to adopt a systematic, student-centred enquiry process. This learning process may be described as a "construction of knowledge" through the use of disciplined inquiry and

the use of PBL in teaching research methods enables instructors to deliver the constructivist philosophy to successfully assist students to create and understand knowledge (Kemp, 2011). An understanding of the constructivist underpinnings of PBL enables instructors to reflect on the goals of teaching and pedagogical strategies to promote learning within the context of courses such as Research methods. One cannot expect that undergraduate research students will understand the entire research discourse after a year's instruction, but we may guide them towards solving a single problem using a single strategy and provide the skills-set required to investigate other problems using similar resources. Other studies have reported that a successful course in research methods at the undergraduate level may foster lifelong learning, professional development and personal growth and further develop self-confidence and self-esteem. In addition, it may inspire them to pursue postgraduate studies with more confidence (Dohm & Cummings, 2002; Waite & Davis, 2006; Crooks, Castleden, and Meerveld, 2010; Lombard & Kloppers, 2015).

South African HEIs need to strategise around building a strong research base that is underpinned by developing critical thinking and problem solving skills. At the same time, there is a need to be responsive and relevant to the current problems faced by community. Problem based learning provides the opportunity to combine these goals to facilitate learning in a subject that has been reported to be complex and difficult to both facilitate and understand. Delivery of PBL may vary from the 'pure' PBL (presentation of the problem with no prior lectures or presentation of other materials) model where students work in small groups with a facilitator, to a 'hybrid' model where students are supported by lectures and greater facilitator intervention (Read, 2010). The 'hybrid' model was adopted in this context and the learning outcomes were achieved successfully. Flexibility and consideration of context, resources and prior learning is imperative in using the PBL approach to teach undergraduate research methods.

5. Conclusion

Research methods are a pivotal course for undergraduate health science students, as they are required to address a myriad of community health issues in their professional lives. Empowering students with skills to identify a problem and to look for plausible solutions in a systematic and scientific manner strengthen the students' ability to work, think and practice independently. This evaluation showed that the PBL was generally successful as students felt that they used self-directed learning with instructor facilitation and supervision to reach their goal of developing independent research proposals. In addition, they recognised that they would be able to use these skills in the workplace and some were motivated to pursue postgraduate work. Problem-based learning requires significant commitment from both the student and the facilitator but it has the potential to build research capacity and support the postgraduate initiative in South African institutions of higher learning.

References

Biggs, J. 1999. What the student does: Teaching for enhanced learning. *Higher Education Research and Development*, 18, 55–75. https://doi.org/10.1080/0729436990180105

Carlisle, C. & Ibbotson, T. 2005. Introducing problem-based learning into research methods teaching: Student and facilitator evaluation. *Nurse Education Today,* 25, 527–541. https://doi.org/10.1016/j.nedt.2005.05.005

Crooks, V.A., Castleden, H. & Meerveld, I.T. 2010. Teaching research methods courses in human geography: Critical reflections. *Journal of Geography in Higher Education,* 34(2), 155–171. https://doi.org/10.1080/03098260903093646

Denham, B. 1997. Teaching research methods to undergraduates. *Journalism & Mass Communication Educator,* 51(4), 54–62. https://doi.org/10.1177/107769589605100407

Dohm, F., & Cummings, W. 2002. Research mentoring and women in clinical psychology. *Psychology of Women Quarterly,* 26(2), 1–9. https://doi.org/10.1111/1471-6402.00055

Earley, M.A. 2014. A synthesis of the literature on research methods education. *Teaching in Higher Education,* 193, 242–253. https://doi.org/10.1080/13562517.2013.860105

Hmelo-Silver, C.E. 2004. Problem-based learning: What and how do students learn? *Educational Psychology Review,* 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Kemp, S. 2011. Constructivism and problem-based learning. *Learning Academy*, 45–51.

Kirschner, P.A., Sweller, J. & Clark, R.E. 2006. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist,* 41(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Lehti, S. & Lehtinen, E. 2005. Computer-supported problem based learning in the research methods domain. *Scandinavian Journal of Educational Research*, 49(3), 297–324. https://doi.org/10.1080/00313830500109618

Lombard, B.J.J. & Kloppers, M. 2015. Undergraduate student teachers' views and experiences of a compulsory course in research methods, South Africa. *South African Journal of Education,* 35(1), 1–14. https://doi.org/10.15700/201503070032

National Development Commission. 2013. National development plan: vision for 2030. Available at www.gov.za/sites/www.gov.za/files/devplan_2.pdf [Accessed 25 October 2016].

Read, J.M. 2010. Teaching introductory geographic information systems through problem-based learning and public scholarship. *Journal of Geography in Higher Education*, 34(3), 379–399. https://doi.org/10.1080/03098265.2010.490909

Richardson, V. 2003. Constructivist pedagogy. *Teachers College Record,* 105(9), 1623–1640. https://doi.org/10.1046/j.1467-9620.2003.00303.x

Ryan, M., Saunders, C., Rainsford, E. & Thompson, E. 2014. Improving research methods teaching and learning in politics and international relations: A 'reality show' approach. *Learning and Teaching in Politics and International Studies,* 34(1), 85–97.

Sonn, R. 2016. The challenge for a historically disadvantaged South African university to produce more postgraduate students, South Africa. *South African Journal of Higher Education,* 30(1), 226–241.

Tashakkori, A. & Teddlie, C. 2003. Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International Journal on Social Research methods,* 6(1), 61–77.

United Nations Development Programme. 2017. Sustainable development goals. Available at http://www.undp.org/content/undp/en/home/sustainable-development-goals.html [Accessed 01 April 2017].

Wagner, C., Garner, M. & Kawulich, B. 2011. The state of the art of teaching research methods in the social sciences: towards a pedagogical culture. *Studies in Higher Education,* 36(1), 75–88. https://doi.org/10.1080/03075070903452594

Waite, S. & Davis, B. 2006. Developing undergraduate research skills in a faculty of education: motivation through collaboration. *Higher Education Research & Development*, 25(4), 403–419. https://doi.org/10.1080/07294360600947426