Problem-based learning as a cross-curricula approach with middle and secondary teacher-education students.

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Abstract
Flinders University introduced the Problem Based Learning (PBL) as a new pedagogy for middle and secondary Bachelor of Education students in 2003, within a compulsory topic covering child development, learning and teaching. This paper outlines the nature of the course and students’ learning, the processes used in PBL and the links made between university experience and school-based learning during field experience.

Practitioners from secondary schools were original case writers of the ‘problems’ that addressed adolescent development and teachers’ and learners’ issues in the secondary school context. These ‘problems’ served as a core teaching resource for the middle and secondary student-teachers.

Rather than the traditional university didactic teaching methods, the PBL method entailed student-directed learning, with an expectation of team work, individual research for the information needed for the topic and higher order thinking skills. This paper reports on middle and secondary schooling student-teachers’ reactions to PBL. In particular, measures of changes in students’ perceptions of their tutorial performance skills were analysed. These covered a range of competencies including problem solving, learning skills, communication, knowledge building and personal and interpersonal development.

Introduction
This paper outlines the journey of the introduction of Problem Based Learning (PBL) within a core topic, for middle and secondary Bachelor of Education students and reports on the findings of these students’ perceptions of their tutorial performance skills. While part of a larger study comprising of a team of researchers funded by the Teaching and Learning Innovations Grant at Flinders University, my focus for this part of the study on which I report in this paper, is determining whether PBL was a suitable pedagogy for this cohort of students.

Problem Based Learning involves the creation of suitable ‘cases’ or ‘problems’ based on real-life scenarios. Students are required to hypothesise, research and finally explore a range of possible ‘solutions’. It is in the creation of the ‘problems’ or ‘cases’ whereby curriculum is designed. By setting clear course objectives, content can be drawn from various disciplines, thus creating a strong cross-curricula or inter-disciplinary focus. For example, in this study, we drew from the disciplines of psychology, philosophy and sociology and invited input from colleagues who are working in these various disciplines to produce ‘the
problems or cases’ set for a topic, Development Learning and Teaching (DLT). This multi-disciplinary approach promotes a coordinated and collaborative teaching environment. This planned curriculum however also embraces an emergent curriculum as it seems that the power of PBL lies in the inevitability of a cross-curricula outcome. In other words the processes and structures within the PBL pedagogy in themselves develop curriculum that is relevant to the particular course participants. This notion of ‘unplanned’ curriculum underpins the richness of the PBL method resulting in surprises especially for the PBL teacher, as the curriculum which emerges is often broader and deeper than originally intended. Not only are the answers or rather ‘solutions’ to the cases open to uncertainty but so too is the learning journey itself. These two unpredictable factors create a great challenge for the ‘teacher’ who is no longer the person who ‘determines what, when and how learners will learn’ (Spencer & Jordan, 1999, p.1283). Rather the PBL method requires the teacher to be able to ‘let go’. The control for the teacher is in the development of cases and from there forwards there is a power shift from teacher directed to learner directed (McPhee, 2002, p.6). Once this is achieved, the way forward is opened up for the learner to determine the ‘what, when and how’ of learning and inevitably this will cross traditional discipline boundaries.

The topic undertaken by the student-teachers involved in this study, Development Learning and Teaching (DLT), has a set of objectives which are designed to be met through the solving of the ‘cases’ or ‘problems’. As mentioned earlier, curriculum is therefore created during the writing of the ‘case’ but not necessarily linked purely to the objectives. Part of the difficulty for teachers perhaps, especially in the tertiary sector is that PBL necessitates a ‘letting go’ of control of the curriculum, once the ‘problems’ have been written. The students’ interests, hypotheses and previous life-experiences all play a part in their responses and in the research avenues they take during the topic. Smith & Lovat, (2003, p.122) summarise this concept of open-ended curriculum in saying ‘Teachers can plan a learning activity but cannot plan the learner’s experience as an experience is an individual phenomena’. PBL requires the teacher therefore to take a leap of faith in anticipating that suitable learning will in fact occur and that this may not line up solely with the intended learning set in the objectives. It seems that PBL epitomises the notion of teacher as ‘part of’ as against ‘maker of’ curriculum as summarised by Clandinin & Connelly, (1992 p.365 & 392) the ‘teacher is seen as an integral part of the curricular process and in which teacher, learners, subject matter and milieu, are in dynamic interaction’.

We cannot hope to include all that we think needs to be taught yet paradoxically the anecdotal evidence is that students often surpass teacher expectations in the breadth and depth of their understanding and learning through the PBL method (Murray-Harvey & Slee, 2000). Suffice to say a PBL approach acknowledges that we cannot have control over what a student actually learns, we can only guide,
scaffold and provide structures and vehicles for learning. PBL appears to result in a richness of understanding of the ‘professional context’ in ways beyond our expectations.

Background
The Problem Based Learning method was introduced within a core topic, Development Learning and Teaching (DLT), to Flinders University Bachelor of Education (B Ed) middle and secondary schooling student-teachers, in 2003. ‘Cases’, otherwise termed ‘problems’ in the PBL literature were created and written by practicing secondary school teachers in collaboration with tertiary teacher-educators. The ‘problems’ addressed adolescent development and learning and teaching issues in the secondary school context. The topic Development Learning and Teaching had previously been taught to secondary student-teachers using traditional text-book based and seminar/tutorial format. To the best of our knowledge, there is no other course in secondary teacher-education in Australia using a PBL approach in a topic on adolescent development. The PBL method was however introduced to the Bachelor of Education primary-education students at Flinders University in 2000 (Murray-Harvey & Slee, 2000).

This core topic spans six weeks of university classes followed by four weeks practicum placement and a further four weeks of university classes. The PBL aspect of this course for teacher-education-students in secondary schools, that is Flinders students within the Middle Schooling, Secondary and Secondary Science B Ed courses, aimed to link theory to practice in a direct way by encouraging the teacher-education students to share elements of the ‘problems’ with their cooperating teachers while on practicum. Students were able to ask for their cooperating teachers’ views and find out what would happen in a similar circumstance in their practicum school. This served to increase the experiential component of PBL and provided a fluid link between university teaching and the practicum experience. It was a deliberate attempt to link field experiences with the on-campus learning to overcome what Siegel (2002, p.2) refers to as ‘a weakness of pre-service teaching programs...that are independent and do not build on each other’.

Problem Based Learning Strategy
Problem Based Learning involves a strong focus on student directed learning. The carefully crafted ‘problems or cases’ are presented page by page over a number of tutorials. The information is revealed gradually in order to ‘disrupt patterns of thinking’ (Kain, 2003, p. 228) which otherwise might lead to inappropriate conclusions. The students, as a whole class, examine the information given and record on a whiteboard the implications arising from this new information and subsequently develop hypotheses as to what might be
happening behind the scenes of the situation. Students take turns in being the scribe, as the principle of shared responsibility for learning, is a strong feature of PBL pedagogy. Students then determine within fixed small groups the learning tasks which each will explore over the next week. These groups operate using cooperative learning principles whereby the students are interdependent in achieving group goals yet maintain individual accountability, (Slavin, 1999, p.74). The students are provided with a reference list of articles which are kept for them on reserve in the library. This provision of references helps to ‘scaffold’ the content of their readings and research, while not restricting them to a limited range of literature. The students subsequently pool the findings of their research within their small group at the next tutorial, drawing from the literature, relevant web-sites and discussions with professionals in the field. Further pages of information on ‘the problem’ are distributed and the process repeated in successive tutorials, until the final page of the problem is presented in the third tutorial. Students then decide on a range of ‘solutions’ to ‘the problem’ and make a group presentation assessed by their peers and tutors. In addition, the principle of ‘embedded assessment’ (Sage & Torp, 1997 p.34) was achieved whereby students prepared a ‘report for the principal’ in their role as ‘teacher in the authentic problem’ outlining their solutions. Tasks such as these help the students to make a shift from viewing themselves as a student but rather from the professional teacher’s perspective (Kain, Hays & Wonderlich, 2000, p.300) and reinforces the shifts of power from tutor to learner, (McPhee, 2002). The second ‘case’ is then started and the process repeated culminating in a presentation of ‘solutions’ at a mini-conference.

There are several principles underlying the PBL method. As mentioned earlier, student or learner-directed learning is a fundamental principle. This can be challenging for students who have previously experienced teacher-directed courses. Many of the middle and secondary pre-service teachers in the current B Ed courses had experienced disjointed curricula and largely teacher-directed lectures and tutorials with assessment based on individual methods of essays and exams, in their previous years of university studies. Taking what might be termed leadership roles in their own learning through PBL provided a different tertiary experience for these students.

Team work is a further essential aspect of the PBL method and sets the scene for self-directed learning. It is imperative to set the group tasks so that the students are interdependent yet with individual accountability. The search for a group consensus on ‘possible solutions’ for the ‘problem’ ensures that students are dependent on one another to research a specific issue and to read specific references. It soon becomes apparent therefore if any group member is not ‘pulling their weight’. The students are encouraged, by explicitly naming the potential for group work issues at the beginning of the course, to work through any workload or personality issues themselves, as this is seen as preparation of requirements for the workplace situation. As Hargreaves (1998) points out,
teaching is an emotional practice and PBL provides a forum for this aspect of personal development to flourish. For example learning to trust one another to complete their set tasks between tutorials and learning to appreciate the differences in each others’ learning and working styles, is a great challenge for the students, (Kain, Hays & Wonderlich, 2000, p.301). PBL clearly acts as a vehicle for the development of a ‘community of colleagues’ (Hargreaves & Fullan, 2000 p.52). At the same time there is scope for individual research since there are a number of hypotheses developed among the class from which individual students can follow their personal interests and explore areas of the literature pertaining to their chosen line of investigation. Hence PBL involves a weaving of interdependence and individual accountability.

As discussion is a strong focus of this method, students inevitably confront their own biases while discussing the various issues surrounding the ‘problem’. They are also ‘forced’ to look underneath and beyond presenting features of ‘the problem’ and grapple with the possibility of a number of possible solutions. One of the most challenging aspects of PBL for teacher-education students is the ambiguity of the issues which confront schools and the absence of ‘the right answer’. Students therefore are required to gather, analyse, synthesise and create pathways forward for ‘the problem’. In fact the naming of what the students’ don’t know (White, 1996, 2001,p.135; Duch, Groh & Allen, 2001, p.135) is encouraged as this process entices the students to research more broadly and to be aware that as professionals they will be making hypotheses which need to be checked out, rather than jumping to conclusions. Students are encouraged to question their own and each others’ interpretations of both the ‘readings’ and the information exposed in the ‘cases’. These higher order thinking skills are an important feature of PBL and may help to develop what Blackmore, 2000 (in Hargreaves, 2001, p.83) describes as the need for teachers to develop ‘resilience to deal with ambiguity’.

PBL is therefore an effective method for fostering team work which is important to develop in teacher-education students, if they are to contribute to the re-culturing of schools. Hargreaves and Fullan (2000 p.51) refer to the ‘professional age’ whereby instead of teachers teaching ‘alone’, rather they ‘are more effective when they can learn from and be supported by a strong community of colleagues.’ (Hargreaves & Fullan 2000 p.52). Team work is an essential prerequisite for this type of collegial re-culturing.

It is acknowledged by Kain (2000) that the PBL method occurs only in recent years in texts on teaching pedagogy. Given that the widespread use of interdisciplinary teaching in schools is a recent phenomenon (Spalding 2002, p. 700), combined with the situation that many of our teacher-education students are of mature age, it is likely that few of these pre-service teachers have experienced PBL themselves as learners in the secondary setting. As there is a tendency for teachers to teach as they themselves were taught (Hargreaves,
2001, p.81), it seems essential therefore that secondary teacher-education students should experience the PBL method themselves as learners, albeit in the tertiary setting, if they are expected to add this method to their repertoire of teaching skills which they will use among a ‘variety of models’ (Kain, 2000, p.13) when in their own classroom.

Given that this tertiary experience of PBL is likely to influence these pre-service teachers in adopting the method in their pedagogical choices in their own classrooms, it was important to gain the students’ perceptions of their experience so that appropriate refinements can be made to the topic in subsequent years. We wanted to know if this Problem Based Learning was a suitable teaching strategy with this cohort of secondary student-teachers as had already been determined with primary student-teachers (Murray-Harvey & Slee, 2000).

Method
In order to determine the suitability of using the strategy of PBL with middle and secondary schooling student-teachers, students’ reactions were gathered using two types of questionnaires. A qualitative questionnaire titled ‘Just a Minute’, was composed of six questions. This was distributed at the end of the first ‘problem’ that is at the end of the third tutorial using PBL, seeking students’ opinions on the strategy itself. For example students were asked ‘What has been the most useful or meaningful thing you have gained from sessions to date?’ and ‘How has your learning in the PBL class been different from (or similar to) other university classroom learning experiences?’

Data were collected, using a second questionnaire comprising self-report forms, titled Assessment of Student’s Problem Based Learning Performance, on students’ perceptions of their competence in the four scales of Problem-Solving and Learning Skills, Communication Skills, Knowledge Building and the fourth being Personal and Interpersonal Development. This was administered at the completion of the first ‘case’, called Harvey High, that is at the end of the third tutorial and again 10 weeks later, at the end of the second ‘case’, called Sunnyvale Secondary School. Students were asked to rate themselves on several statements under each of the four competencies. For example, in response to the statement under the Problem Solving and Learning Skills competency, ‘I am able to generate relevant hypotheses to explain the problem under discussion’, students needed to rate themselves as ‘Highly competent’, ‘Competent’, and ‘Becoming competent’ or ‘Not competent’. A further example this time within the Personal and Interpersonal Development competency, students responded to the statement ‘I can identify my own strengths and limitations’ as ‘Highly competent’, ‘Competent’, ‘Becoming competent’ or ‘Not competent’
In addition, the students were invited to make comments under each of the four competencies on these same questionnaires regarding their tutorial performance skills.

Results and Discussion
The students’ reactions in the ‘Just a Minute’ questionnaire included a range of comments covering the following aspects; learning from peers, deeper understanding of issues presented in the ‘cases’, applying the problem solving skills in the practical situation, the emphasis on group work and student-directed learning. For example in response to the question, ‘What has been the most useful or meaningful thing you have gained from sessions to date?’ comments included:

These sessions have enhanced my critical thinking, putting forward hypotheses and evaluation of new information
How complicated people are
Learning about how students develop
Experiencing a shared responsibility regarding analysing exercises and readings
Listening to other students’ opinions

Further examples of responses following the question ‘How has your learning in the PBL class been different from (or similar to) other university classroom learning experiences?’ include the comments:

Vastly different!! Never experienced group work like this, only Uni tutorials with once a semester contribution to the group ‘This is my first experience of PBL, it’s a bit overwhelming.
The readings. Never done any before so found it hard and long.

While there were a range of negative comments such as: PBL is very time consuming and I found it hard to learn with the PBL style, the majority of these students’ first impressions were in support of the PPL strategy.

Eighty-four students completed the Assessment of Student’s Problem Based Learning Performance questionnaires on both ‘cases’ Harvey High and Sunnyvale Secondary for all four competency scales. T-tests were conducted on the data gathered from the self-rating responses, indicating that the students’ perceived themselves as performing significantly better on all four scales of measurement at the completion of the second case than on the first, as shown in Table 1.
Table 1: Comparison of middle and secondary schooling teacher-education students’ self ratings of tutorial performance on the first and second PBL cases

<table>
<thead>
<tr>
<th>Scale</th>
<th>N cases</th>
<th>Difference score</th>
<th>T value of difference score</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-solving</td>
<td>86</td>
<td>-1.407</td>
<td>-5.74</td>
<td>.000</td>
</tr>
<tr>
<td>Communication skills</td>
<td>84</td>
<td>-2.381</td>
<td>-7.03</td>
<td>.000</td>
</tr>
<tr>
<td>Knowledge building</td>
<td>85</td>
<td>-1.929</td>
<td>-7.51</td>
<td>.000</td>
</tr>
<tr>
<td>Personal development</td>
<td>87</td>
<td>-1.448</td>
<td>-5.40</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 1 indicates that there was a significant difference in the improvement in Problem Solving and Learning Skills as perceived by these middle and secondary student-teachers. The students’ additional comments on the questionnaire following the second ‘case’ Sunnyvale Secondary School, highlighted this perceived improvement. Their comments included for example:

- “I feel I have developed further in all skills but still have trouble sometimes generating hypotheses. Brainstorming and input from others in the group helps sort problems in an organised way. I developed my skills in terms of applying information and evaluating approaches.”

There was a significant difference in perceived improvements in Communication Skills. These examples of student comments support this significant improvement:

- “Working through the problems enhanced certain conflict resolution skills I’ve enjoyed working in this group. It has taught me more about myself and in particular what areas I would like to improve on especially evaluating hypotheses. Communication skills have strengthened immensely. Most invaluable group work I’ve ever done’

Knowledge Building Skills also developed significantly with student comments acknowledging their perceived improvements:

- “I really enjoy analysing and building knowledge from the ‘cases’ I’ve realised that there will always be areas of thought and knowledge that I am blind to but therein lies the importance of a critical outlook. I recognise the knowledge that I don’t know but now realise what I need to learn more of and the importance of understanding all resources.”
The fourth competency comparison, Personal and Interpersonal Development, also showed a significant improvement. Student comments supported the perceived changes:

- I have not attempted as many group roles as I would have liked due to time restrictions but feel this is something I can improve on.
- I have learned a lot about the way I participate in a group through working on the PBL presentation. It has helped me to encourage others to contribute.
- I’ve worked hard on my own skills in a group too.
- I am a keen group member and know my strengths and weaknesses. I need to work on my responses to feedback.
- Started to feel more confident working in a group.

The data were tested for gender effect. One gender effect only resulted, showing that the male middle and secondary teacher-education students perceived greater improvement in their communication skills level than females. There was no further gender effect however on the sub-scales of problem solving, knowledge building and personal development.

The results do not indicate what the significant differences on the four competencies on the Assessment of Student’s Problem Based Learning Performance can be attributed to. It is possible that in regard to the ‘cases’ themselves, one may have seemed easier or more interesting than the other. It must also be noted that an influencing factor may have been associated with the timing of the completion of the two questionnaires. The first questionnaire was administered after only three tutorials run over successive weeks whereas the second questionnaire was administered three months after the commencement of the PBL course. This arose as the second ‘case’ was introduced immediately following the first case, conducted for two successive weeks, followed by a gap of two weeks for the mid-semester break. Students attended a further four week practicum in school settings. The third tutorial for the second case, was held therefore several weeks after the second tutorial providing opportunities for the students to discuss the ‘case’ in the ‘real world school setting’. Following the third tutorial held back in the university setting, students spent three more weeks discussing the ‘case’ in order to plan their presentations of ‘solutions’ at a mini-conference. The questionnaire was administered a second time after the presentations at the mini conference. It can be said therefore that the students spent far more time considering the second case than the first. The students also spent more time with their small group peer members and therefore knew each other better and hopefully had developed more trust in one another than in the first ‘case’. While the ‘cases’ or problems’ are a core teaching resource of PBL, it is not only the ‘case’ however that is of specific interest to the present study but also the ‘method’ of problem-based learning’ and the particular design of the structure of this topic which includes the linking of the ‘practical with the theory’. In other words, my argument is that Problem-Based Learning is merely the vehicle for exciting curricula to emerge as a result of several principles and
other factors combining simultaneously. These include, a focus on reflexive practice through the use of journal writing throughout the topic; self-directed learning by expecting the students to set their own learning tasks through researching the literature each week; the use of authentic assessment in which the students are required to write a ‘report to the school principal’ within the ‘case’; the provision of a real world learning environments through the ‘cases or problems’ which are embedded in their future professional work contexts; a four week practicum placement in the middle of a ‘case’ whereby student-teachers seek the opinions of their cooperating teachers in the field, while experiencing first-hand the complexities of what it means to ‘be a teacher in a school setting’. This latter element of the PBL experience should demonstrate to the teacher-education students that their teacher education course will not cover all they need to know but that as future teachers they will require skills in being selective about what, how and when they learn and further, that they will be able to apply their learning in the complex school setting for the benefit of the students they in turn will be teaching. ‘Fast, efficient, independent’ (Iglesias & Vera, 2001, p.5) and in addition, interdependent learning is necessary if student teachers will ‘need to know what is needed to understand, solve and improve a particular situation.’ (Iglesias & Vera, 2001, p.6). The PBL method along with other structures which support constructivist learning, propels students to arrive at this acknowledgement.

Whatever the reasons, the fact that there is a significant increase in students’ perceptions in all four measures suggests that at least from their point of view, the learning has been valuable. It is acknowledged however that student self-reporting cannot be assumed as necessarily to be reliable (Greening, 1998, p.9-10).

The significant increase across all four measures is a particularly pleasing result with this cohort of middle and secondary teacher-education students. Anecdotally, at the beginning of the topic some students were expressing their skepticism, hesitancy and outright dislike of the PBL method. Students were critical of several aspects of PBL including the large amount of reading involved, the ambiguity of the ‘cases’ and as one student remarked ‘I find it hard to remain focussed as there are so many factors to consider in relation to adolescence and learning.’ Many students expressed that the teaching method prevailing in their undergraduate degrees or majors’ had been read-listen-regurgitate through lectures and assessments such as essays and exams and that they were struggling with this ‘group discussion, express your own opinions, self-directed learning’ focus of PBL. These attitudes of middle and secondary teacher-education students are not uncommon and are echoed elsewhere in the literature (Iglesias & Vero, 2001, p.9).

Other studies, predominantly in the medical literature on PBL, have found little evidence that PBL produces greater knowledge and professional skills over
conventional methods of teaching (Colliver, 2000; Dyke, Jamrozik & Plant, 2001; Dochy, Siegers, Van den Bossche & Gijbels, 2003). These same authors acknowledge however that PBL produces high motivation and enjoyment for students and that richer and deeper learning occurs, aiding the retention of information. It is in the area of self-directed learning and competencies in cooperation that PBL is accredited with superior results (Colliver, 2000; Dyke, Jamrozik & Plant, 2001; Schmidt & Molen, 2001).

Conclusion
This study shows that there were significant differences between Case 1 (Harvey High) and Case 2 (Sunnyvale Secondary School) for the four competencies comprising of Problem Solving and Learning Skills, Communication Skills, Knowledge Building and Personal and Interpersonal Development, as perceived by middle and secondary schooling student-teachers. This suggests that the strategy of Problem Based Learning is effective for this group of pre-service teachers. As outlined in the introduction, PBL is a complex teaching method, steeped in constructivism and the richness of the underlying principles of PBL combined with the process, structures, context and prior experiences of the students that contribute to the success of this cross-curricula approach to teaching and learning. It would seem suitable pedagogy for future middle and secondary teachers of the 21st Century, if they are to inspire their own students in turn, to develop a ‘life-long habit of self-directed learning’ (Colliver, 2000 p.265). Clearly, Problem Based Learning within this DLT topic which covers adolescent development, teaching and learning makes significant inroads into the development of pre-service teachers’ understanding of their ‘future occupational world’ in which they will be a ‘professional educator’ (Kain, 2003, p.6). This study, which as mentioned earlier, is part of a larger study and lends itself to future research which may look at further ways to incorporate PBL in tertiary studies.

References


Iglesias, J. & Vera, R. (2001) Problem-based learning in an initial teacher education program at the University of Atacama. International Yearbook on the Teacher Education 46th World Assembly Santiago, Chile


